Yellowstone Grizzly Bear Investigations 2009

Report of the Interagency Grizzly Bear Study Team

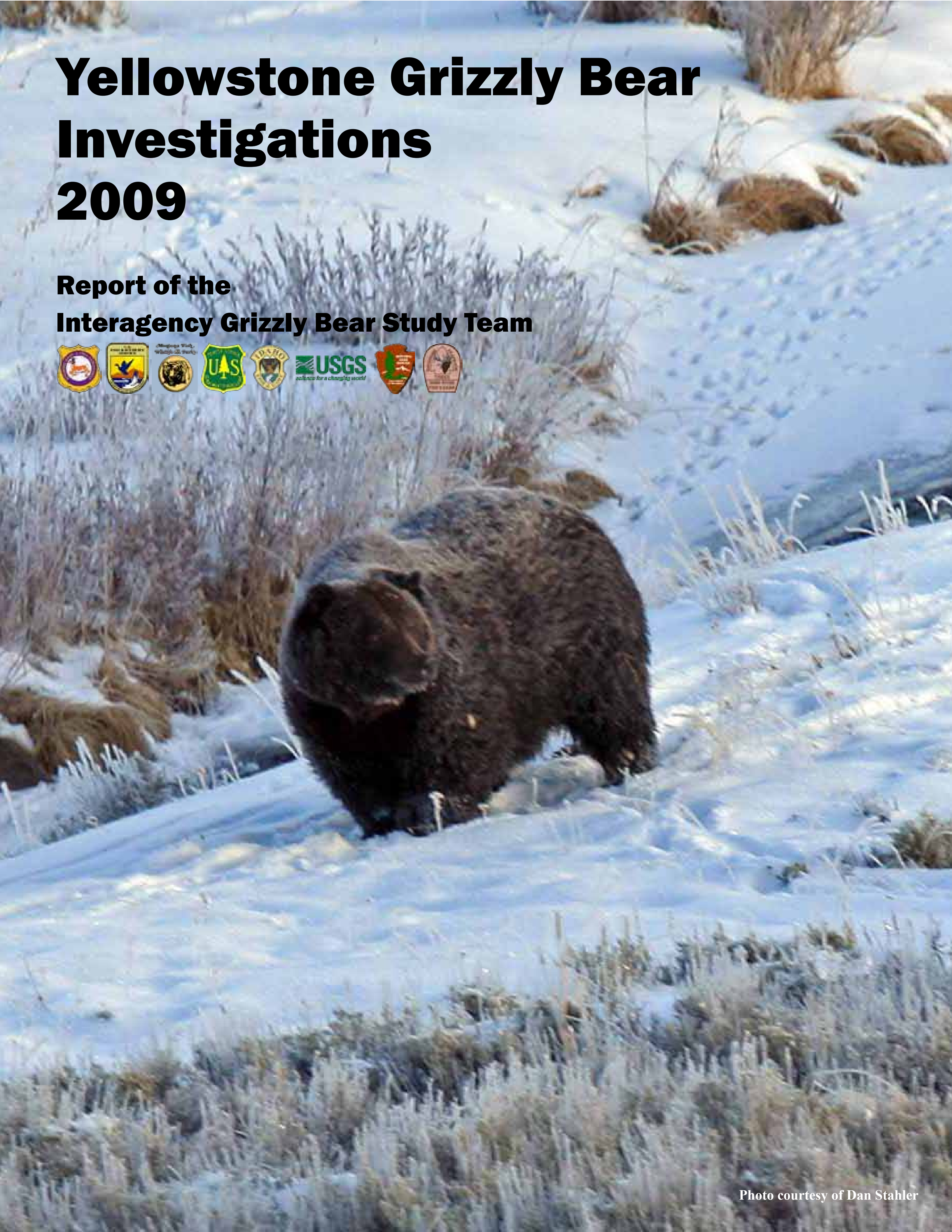

Photo courtesy of Dan Stahler

Cover: Fat grizzly bear in Gardner's Hole, Nov 2009. Photo courtesy of Dan Stahler/NPS.

YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

Annual Report of the Interagency Grizzly Bear Study Team

2009

U.S. Geological Survey
Wyoming Game and Fish Department
National Park Service
U.S. Fish and Wildlife Service
Montana Fish, Wildlife and Parks
U.S. Forest Service
Idaho Department of Fish and Game
Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department

Edited by Charles C. Schwartz, Mark A. Haroldson, and Karrie West

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U.S. Geological Survey
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Introduction

(*Charles C. Schwartz, Interagency Grizzly Bear Study Team, and David Moody, Wyoming Game and Fish Department*)

This Report

The contents of this Annual Report summarize results of monitoring and research from the 2009 field season. The report also contains a summary of nuisance grizzly bear (*Ursus arctos horribilis*) management actions.

The Interageny Grizzly Bear Study Team (IGBST) continues to work on issues associated with counts of unduplicated females with cubs-of-the-year (COY). These counts are used to estimate population size, which is then used to establish mortality thresholds. A recent review published in the Journal of Wildlife Management (Schwartz et al. 2008) suggest that the rule set of Knight et al. (1995) returns conservative estimates, but with minor improvements, counts of unduplicated females with COY can serve as a reasonable index of population size useful for establishing annual mortality limits. As a follow up to the findings of Schwartz et al. (2008), the IGBST held a workshop in October 2007 (IGBST 2008:Appendix F). The purpose of the workshop was to discuss the feasibility of developing new models that improve our ability to distinguish unique females with COY. The outcome of that workshop was a research proposal detailing methods to develop a hierarchical model that should improve the methods used to distinguish unique females with COY. Multiple agencies who are members of the Yellowstone Grizzly Bear Coordinating Committee provided funding for this project. There were some unanticipated delays in getting all the money transferred and as a result we did not get the project started in early 2009 as anticipated. However, the project is now active and we anticipate results to be available by sometime in 2010.

The grizzly bear was removed from protection under the Endangered Species Act on 30 April 2007 (U.S. Fish and Wildlife Service [USFWS] 2007*a*) but relisted by court order in 2009. Although the status changed, we continue to follow monitoring protocols established under the Revised Demographic Recovery Criteria (USFWS 2007*b*) and the demographic monitoring section of the Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007*c*). The IGBST will continue reporting on an array of required monitoring programs. These include both population and habitat components. Annual population monitoring includes:

- Monitoring unduplicated females with COY for the entire Greater Yellowstone Area (GYA).
- Calculating a total population estimate for the entire GYA based on the model averaged Choa2 estimate of females with COY.
- Monitoring the distribution of females with young of all ages and having a target of at least 16 of 18 Bear Management Units (BMUs) within the Recovery Zone (RZ) occupied at least 1 year in every 6, and no 2 adjacent BMUs can be unoccupied over any 6-year period (see *Occupancy of bear management units by females with young*).
- Monitoring all sources of mortality for independent females and males (≥2 years old) within the entire GYA. Mortality limits are set at ≤9% for independent females and ≤15% for independent males from all causes. Mortality limits for dependent young are ≤9% for known and probably human-caused mortalities (see *Estimating sustainability of annual grizzly bear mortalities*).

Habitat monitoring includes documenting the abundance of the 4 major foods throughout the GYA including winter ungulate carcasses, cutthroat trout (*Oncorhynchus clarkii*) spawning numbers, bear use of army cutworm moth (*Euxoa auxiliaris*) sites, and whitebark pine (*Pinus albicaulis*) cone production. These foods have been monitored by the IGBST for several years and are reported here. Additionally, we continued to monitor the health of whitebark pine in the ecosystem in cooperation with the Greater Yellowstone Whitebark Pine Monitoring Working Group. A summary of the 2009 monitoring is also presented (Appendix D). The protocol has been modified to document mortality rate in whitebark pine from all causes, including mountain pine beetle (*Dendroctonus ponderosae*).

Although monitoring requirements under the Conservation Strategy (USFWS 2007*c*) do not apply since the bear was relisted, the Forest Service will continue to report on items identified in the Strategy including changes in secure habitat, livestock allotments, and developed sites from the 1998 baseline levels in each BMU subunit. This year, the third report detailing this monitoring program is provided. This report documents 1) changes in secure habitat, open motorized access route density, total motorized route density inside the RZ, 2) changes in number and capacity of developed sites inside the RZ, 3) changes in number of commercial livestock allotments and changes in the number of permitted domestic sheep animal months inside the RZ, and livestock allotments with grizzly bear conflicts during the last 5 years (see Appendix In preparation).

Results of DNA hair snaring work conducted on Yellowstone Lake (Haroldson et al. 2005) from 1997–2000 showed a decline in fish use by grizzly bears when compared to earlier work conducted by Reinhardt (1990) in 1985–1987. As a consequence, the IGBST started a 3-year study to determine if spawning cutthroat trout continue to be an important food for bears, or if the trout population has declined to the level that bears no longer use this resource. If trout are no longer a useful food resource, we want to determine what geographical areas and foods the bears are using and if those foods are an adequate replacement to maintain a healthy population of grizzly bears. This project began in 2007 and field work was complete in 2009. There were 2 graduate students and several field technicians working on the program. A summary of the 2009 field work can be found in Appendix A.

The state of Wyoming, following recommendations from the Yellowstone Ecosystem Subcommittee and the IGBST, launched the Bear Wise Community Effort in 2005. The focus is to minimize human/bear conflicts, minimize human-caused bear mortalities associated with conflicts, and safeguard the human community. Results of these efforts are detailed in Appendix B. Also, the state of Wyoming, conducted a field study testing remote sensing cameras to document the presence of grizzly bears on the periphery of their distribution. Results of that study are reported in Appendix C.

The annual reports of the IGBST summarize annual data collection. Because additional information can be obtained after publication, <u>data summaries are subject to change</u>. For that reason, data analyses and summaries presented in this report supersede all previously published data. The study area and sampling techniques are reported by Blanchard (1985), Mattson et al. (1991*a*), and Haroldson et al. (1998).

History and Purpose of the Study Team

It was recognized as early as 1973, that in order to understand the dynamics of grizzly bears throughout the Greater Yellowstone Ecosystem (GYE), there was a need for a centralized research group responsible for collecting, managing, analyzing, and distributing information. To meet this need, agencies formed the IGBST, a cooperative effort among the U.S. Geological Survey (USGS), National Park Service, U.S. Forest Service, USFWS, and the States of Idaho, Montana, and Wyoming. The responsibilities of the IGBST are to: (1) conduct both short- and long-term research projects addressing information needs for bear management; (2) monitor the bear population, including status and trend, numbers, reproduction, and mortality; (3) monitor grizzly bear habitats, foods, and impacts of humans; and (4) provide technical support to agencies and other groups responsible for the immediate and long-term management of grizzly bears in the GYE. Additional details can be obtained at our web site (http://www.nrmsc.usgs.gov/research/igbst-home.htm).

Quantitative data on grizzly bear abundance, distribution, survival, mortality, nuisance activity, and bear foods are critical to formulating management strategies and decisions. Moreover, this information is necessary to evaluate the recovery process. The IGBST coordinates data collection and analysis on an ecosystem scale, prevents overlap of effort, and pools limited economic and personnel resources.

Previous Research

Some of the earliest research on grizzlies within Yellowstone National Park was conducted by John and Frank Craighead. The book, "The Grizzly Bears of Yellowstone" provides a detailed summary of this early research (Craighead et al. 1995). With the closing of open-pit garbage dumps and cessation of the ungulate reduction program in Yellowstone National Park in 1967, bear demographics (Knight and Eberhardt 1985), food habits (Mattson et al. 1991*a*), and growth patterns (Blanchard 1987) for grizzly bears changed. Since 1975, the IGBST has produced annual reports and numerous scientific publications (for a complete list visit our web page http://www.nrmsc.usgs.gov/science/igbst/pubs) summarizing monitoring and research efforts within the GYE. As a result, we know much about the historic distribution of grizzly bears within the GYE (Basile 1982, Blanchard et al. 1992), movement patterns (Blanchard and Knight

1991), food habits (Mattson et al. 1991*a*), habitat use (Knight et al. 1984), and population dynamics (Knight and Eberhardt 1985, Eberhardt et al. 1994, Eberhardt 1995). Nevertheless, monitoring and updating continues so that status can be reevaluated annually.

This report truly represents a "study team" approach. Many individuals contributed either directly or indirectly to its preparation. To that end, we have identified author(s). We also wish to thank USGS: J. Ball, N. Counsell, P. Cross, R. Fitzpatrick, C. Lindbeck, S. McKenzie, K. Miller, M. O'Reilly, T. Rosen, S. Schmitz, J. Teisberg, S. Thompson, C. Whitman, C. Wickhem; NPS: H. Bosserman, A. Bramblett, M. Bretzke, A. Byron, T. Coleman, S. Consolo-Murphy, C. Daigle-Berg, T. Davis, S. Dewey, L. Felicetti, L. Frattaroli, B. Gafney, S. Gunther, B. Hamblin, L. Haynes, B. Jones, D. Smith, D. Stahler, A. Tallian, P.J. White, S. Wolff, B. Wyman; MTFWP: N. Anderson, L. Hanauska-Brown, J. Smith, J. Smolczynski, S. Stewart; WYGF: G. Anderson, T. Achterhof, S. Becker, M. Boyce, D. Brimeyer, G. Brown, J. Clapp, D. Clause, B. DeBolt, D. Ditolla, L. Ellsbury, T. Fagan, G. Fralick, H. Haley, S. Hegg, A. Johnson, N. Johnson, J. Kettley, L. Knox, B. Kroger, M. Ladd, S. Lockwood, L. Lofgren, J. Longobardi, P. Luepke, D. McWhirter, K. Millls, B. Nesvik, C. Queen, R. Roemmich, C. Sax, D. Thompson, B. Trebelcock, Z. Turnbull; IDFG: C. Anderson, S. Grigg, J. Hansen, T. Imthum, R. Knight, J. Koontz, G. Losinski, H. Miyasaki, S. Roberts, J. Rydalch; USFS: M. Cherry, B. Davis, T. Hershey, M. Hinschberger, L. Otto, A. Pils, C. Pinegar, D. Probasco; Shoshone and Arapaho Tribes: B. Makeshine, K. Smith, R. St. Clair, W. Thayer, B. Warren; USFWS: P. Hnilicka, D. Skates; Pilots/Observers: C. Anderson, B. Ard, S. Ard, B. Brannon, N. Cadwell, R. Danielson, D. Ford, K. Hamlin, H. Leach, J. Martin, K. Overfield, M. Packila, T. Schell, D. Stinson, D. Stradley, R. Stradley; WS: G. McDougal, J. Rost; and MSU: S. Cherry for their contributions to data collection, analysis, and other phases of the study. Without the collection efforts of many, the information contained within this report would not be available.

Grizzly bear near trap site on Yellowstone Lake, 24 Jun 2009. Photo courtesy of Gary White.

Results and Discussion

Bear Monitoring and Population Trend

Marked Animals (Mark A. Haroldson and Chad Dickinson, Interagency Grizzly Bear Study Team; and Dan Bjornlie, Wyoming Game and Fish Department)

During the 2009 field season, 79 individual grizzly bears were captured on 97 occasions (Table 1), including 20 females (12 adult), 57 males (38 adult), and 2 yearlings that were released without handling and whose sex was unknown. Fifty-three individuals were new bears not previously marked.

We conducted research trapping efforts for 929 trap days (1 trap day = 1 trap set for 1 day) in the GYE. During research trapping operations we had 63 captures of 48 (10 female, 38 male) individual grizzly bears for a trapping success rate of 1 grizzly capture every 14.7 trap days.

There were 34 management captures of 32 individual bears in the GYE during 2009 (Tables 1 and 2), including 10 females (5 adult), 20 males (12 adult), and 2 yearlings that were released without handling and were not sexed. Twenty-two individual bears (8 females, 14 males), were relocated due to conflict situations (Table 1). There were 7 (2 females, 5 males) management removals, which included 1 female that had been relocated on 2 previous occasions. Four bears captured in management situations were release on site. Two of these were non-target captures during separate management capture efforts at cattle depredations (1 by wolves, 1 by bear), and 2 were yearlings released when an attempt to capture their mother at a conflict site was unsuccessful. Additionally, 1 adult male initially management trapped and relocated was subsequently caught at a research trap site near an active management trapping effort and was transported away from the vicinity of the conflict. Another subadult male caught at a research trap sites was relocated because of his recent conflict history and close proximity to human developments.

We radio-monitored 91 individual grizzly bears during the 2009 field season, including 29 adult females (Tables 2 and 3). Forty-two grizzly bears entered their winter dens wearing active transmitters. One additional bear not located since September is considered missing (Table 3). Since 1975, 626 individual grizzly bears have been radiomarked in the GYE.

Table 1. Grizzly bears captured in the Greater Yellowstone Ecosystem during 2009.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
603	male	adult	04/30/09	E Fork Wind River, Pr-WY	management	Mormon Cr, SNF	WYGF
604	male	adult	05/03/09	S Fork Shoshone River, Pr-WY	management	Lake Cr, SNF	WYGF
			05/17/09	Gravelbar Cr, SNF	research	Pilot Cr, SNF	WYGF
G135	male	adult	05/12/09	Buffalo Fork, Pr-WY	management	removed	WYGF
605	female	subadult	05/15/09	Sunlight Cr, SNF	research	on site	WYGF
G136	male	subadult	05/15/09	Sunlight Cr, SNF	research	on site	WYGF
606	male	adult	05/19/09	Sunlight Cr, SNF	research	on site	WYGF
607	male	adult	05/20/09	Sunlight Cr, SNF	research	on site	WYGF
			06/06/09	Gravelbar Cr, SNF	research	on site	WYGF
G137	male	adult	05/21/09	Sunlight Cr, SNF	research	on site	WYGF
G138	male	adult	05/23/09	Sunlight Cr, SNF	research	on site	WYGF
G139	male	subadult	05/23/09	Wind River, Pr-WY	management	Sheffield Cr, BTNF	WYGF
553	male	adult	05/30/09	Pilot Cr, SNF	research	on site	WYGF
554	female	subadult	05/30/09	West Painter Cr, SNF	research	on site	WYGF
			06/19/09	Reef Cr, SNF	research	on site	WYGF
550	male	adult	06/01/09	Sunlight Cr, SNF	research	on site	WYGF
G140	male	subadult	06/04/09	Pilot Cr, SNF	research	on site	WYGF
			06/12/09	Ghost Cr, SNF	research	on site	WYGF

Table 1. Continued.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
G141	male	subadult	06/07/09	Clark, Pr-WY	management	Boone Cr, CTNF	WYGF
Unm	unknown	subadult	06/07/09	Bennett Cr, Pr-WY	management	on site	WYGF
Unm	unknown	subadult	06/07/09	Bennett Cr, Pr-WY	management	on site	WYGF
608	male	adult	06/09/09	Ghost Cr, SNF	research	on site	WYGF
201	male	adult	06/10/09	Chipmunk Cr, YNP	research	on site	IGBST
			06/26/09	Chipmunk Cr, YNP	research	on site	IGBST
515	male	adult	06/11/09	Cub Cr, YNP	research	on site	IGBST
			07/22/09	Bridge Cr, YNP	research	on site	IGBST
G142	male	subadult	06/11/09	Blaine Cr, Pr-WY	management	removed	WYGF
G143	male	subadult	06/11/09	Deadman Cr, SNF	research	on site	WYGF
609	male	subadult	06/13/09	Antelope Cr, YNP	research	on site	IGBST
204	male	adult	06/15/09	Cub Cr, YNP	research	on site	IGBST
			06/18/09	Alluvium Cr, YNP	research	on site	IGBST
G144	male	adult	06/15/09	Pilot Cr, SNF	research	on site	WYGF
Unm	male	adult	06/24/09	Chipmunk Cr, YNP	research	on site	IGBST
596	female	adult	06/25/09	Bennett Cr, Pr-WY	management	Blackrock Cr, BTNF	WYGF
			08/23/09	Bill Cr, SNF	management	Blackrock Cr, BTNF	WYGF
			11/10/09	Shoshone River, ST-WY	management	removed	WYGF
610	female	adult	06/26/09	Cottonwood Cr, GTNP	research	on site	GTNP
			10/04/09	Snake River, GTNP	research	on site	IGBST
G145	male	subadult	06/28/09	S Fork Shoshone River, Pr-WY	management	Pilot Cr, SNF	WYGF
434	male	adult	06/28/09	Sunlight Cr, Pr-WY	management	Cascade Cr, CTNF	WYGF
568	male	adult	06/29/09	Cub Cr, YNP	research	on site	IGBST
570	male	adult	06/29/09	Flat Mountain Cr, YNP	research	on site	IGBST
448	female	adult	07/09/09	Bridge Cr, YNP	research	on site	IGBST
			07/10/09	Arnica Cr, YNP	research	on site	IGBST
			07/14/09	Arnica Cr, YNP	research	on site	IGBST
			07/23/09	Arnica Cr, YNP	research	on site	IGBST
611	male	adult	07/09/09	Elk Cr, CTNF	management	Thirsty Cr, CTNF	IDFG
G133	male	subadult	07/17/09	Cottonwood Cr, GTNP	research	Glade Cr, JDRMP	GTNP
Unm	female	subadult	07/19/09	Line Cr, BLM-WY	management	removed	WYGF
Unm	male	subadult	07/19/09	Line Cr, BLM-WY	management	removed	WYGF
Unm	male	subadult	07/19/09	Line Cr, BLM-WY	management	removed	WYGF
612	female	adult	07/20/09	Snowshoe Cr, SNF	management	Mormon Cr, SNF	WYGF
589	male	adult	07/22/09	Arnica Cr, YNP	research	on site	IGBST
338	male	adult	07/22/09	Arnica Cr, YNP	research	on site	IGBST
			07/28/09	Bridge Cr, YNP	research	on site	IGBST
481	female	adult	07/23/09	Bridge Cr, YNP	research	on site	IGBST
613	female	adult	07/24/09	Rock Cr, BTNF	management	Fox Cr, SNF	WYGF
614	female	adult	07/26/09	Elk Cr, CTNF	management	on site	IDFG
615	female	subadult	07/28/09	Cottonwood Cr, GTNP	research	on site	GTNP
616	female	adult	07/29/09	Yellowstone River, YNP	research	on site	IGBST

Table 1. Continued.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
617	male	subadult	08/02/09	Fish Cr, BNTF	management	Mormon Cr, SNF	WYGF
Unm	male	subadult	08/08/09	Snowshoe Cr, SNF	management	on site	WS/WYGF
G146	male	adult	08/11/09	Rock Cr, BTNF	management	Mormon Cr, SNF	WYGF
618	male	subadult	08/13/09	Colley Cr, GNF	research	on site	IGBST
333	male	adult	08/20/09	S Fork Shoshone River, SNF	management	Boone Cr, CTNF	WYGF
547	male	adult	08/20/09	N Antelope Springs, CTNF	research	on site	IDFG/IGBST
			08/23/09	N Antelope Springs, CTNF	research	on site	IDFG/IGBST
619	male	subadult	08/20/09	Bootjack Cr, CTNF	research	on site	IDFG/IGBST
620	female	adult	08/25/09	Bootjack Cr, CTNF	research	on site	IDFG/IGBST
621	male	adult	08/26/09	N Antelope Springs, CTNF	research	on site	IDFG/IGBST
622	male	subadult	09/11/09	Vass Cr, BLM-WY	research	on site	WYGF
			09/18/09	Vass Cr, BLM-WY	research	on site	WYGF
623	male	subadult	09/12/09	Vass Cr, BLM-WY	research	on site	WYGF
624	male	adult	09/14/09	Owl Cr, Pr-WY	research	on site	WYGF
G147	male	subadult	09/15/09	Vass Cr, BLM-WY	research	on site	WYGF
625	male	adult	09/18/09	Wagon Cr, BTNF	management	Mormon Cr, SNF	WYGF
626	female	adult	09/19/09	S Fork Owl Cr, BLM-WY	research	on site	WYGF
627	female	adult	09/23/09	Snake River, JDRMP	research	on site	IGBST
424	male	adult	10/01/09	Gardner River, YNP	research	on site	IGBST
526	male	adult	10/02/09	Snake River, GTNP	research	on site	IGBST
G148	male	subadult	10/02/09	Pacific Cr, GTNP	research	on site	IGBST
569	female	adult	10/02/09	Whit Cr, Pr-WY	management	Cascade Cr, CTNF	WYGF
G149	female	subadult	10/02/09	Whit Cr, Pr-WY	management	Cascade Cr, CTNF	WYGF
G150	female	subadult	10/02/09	Whit Cr, Pr-WY	management	Cascade Cr, CTNF	WYGF
G114	male	adult	10/04/09	Pacific Cr, GTNP	research	on site	IGBST
			10/07/09	Snake River, GTNP	research	on site	IGBST
Unm	male	adult	10/06/09	Pacific Cr, BTNF	management	removed	WYGF
260	male	adult	10/07/09	Antelope Cr, YNP	research	on site	IGBST
628	female	subadult	10/12/09	S Fork Shoshone River, Pr-WY	management	Clarks Fork River, SNF	WYGF
629	male	adult	10/12/09	N Fork Shoshone River, Pr-WY	management	Grassy Cr, CTNF	WYGF
630	male	adult	10/14/09	Stephens Cr, YNP	research	on site	IGBST
631	female	subadult	10/14/09	S Fork Shoshone River, Pr-WY	management	Long Cr, SNF	WYGF
228	male	adult	10/15/09	Stephens Cr, YNP	research	on site	IGBST
227	male	adult	10/21/09	Gibbon River, YNP	research	on site	IGBST
			10/28/09	Gibbon River, YNP	research	on site	IGBST
632	male	adult	10/30/09	Twin Cr, Pr-WY	management	Bailey Cr, BTNF	WYGF
633	male	adult	11/03/09	Davis Cr, Pr-MT	management	Trapper Cr, GNF	WS/MTFWP

[a] Unm = unmarked.
[b] BLM = Bureau of Land Management; BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park; JDRMP = John D. Rockefeller Memorial Parkway; SNF = Shoshone National Forest, ST = state land; YNP = Yellowstone National Park, Pr = private.
[c] GTNP = Grand Teton National Park; IDFG = Idaho Fish and Game; IGBST = Interagency Grizzly Bear Study Team, USGS; MTFWP = Montana Fish, Wildlife and Parks; WS = Wildlife Services; WYGF = Wyoming Game and Fish.

Table 2. Annual record of grizzly bears monitored, captured, and transported in the Greater Yellowstone Ecosystem since 1980.

Year	Number monitored	Individuals trapped	Total captures		
			Research	Management	Transports
1980	34	28	32	0	0
1981	43	36	30	35	31
1982	46	30	27	25	17
1983	26	14	0	18	13
1984	35	33	20	22	16
1985	21	4	0	5	2
1986	29	36	19	31	19
1987	30	21	15	10	8
1988	46	36	23	21	15
1989	40	15	14	3	3
1990	35	15	4	13	9
1991	42	27	28	3	4
1992	41	16	15	1	0
1993	43	21	13	8	6
1994	60	43	23	31	28
1995	71	39	26	28	22
1996	76	36	25	15	10
1997	70	24	20	8	6
1998	58	35	32	8	5
1999	65	42	31	16	13
2000	84	54	38	27	12
2001	82	63	41	32	15
2002	81	54	50	22	15
2003	80	44	40	14	11
2004	78	58	38	29	20
2005	91	63	47	27	20
2006	92	54	36	25	23
2007	86	65	54	19	8
2008	87	66	39	40	30
2009	97	79	63	34	25

Table 3. Grizzly bears radio monitored in the Greater Yellowstone Ecosystem during 2009.

Bear	Sex	Age	Offspring[a]	Monitored		Current Status
				Out of den	Into den	
179	F	adult	2 yearlings	yes	no	cast
201	M	adult		no	no	cast
204	M	adult		yes	no	cast
211	M	adult		yes	no	cast
227	M	adult		no	yes	active
246	F	adult	not seen	yes	no	cast
260	M	adult		no	yes	active
279	F	adult	4 COY, lost 1	yes	yes	active
289	F	adult	1 yearling, lost	yes	yes	active
295	F	adult	not seen	no	no	cast
302	M	adult		yes	yes	active
333	M	adult		no	yes	active
338	M	adult		no	no	cast
360	F	adult	2 COY	yes	yes	active
363	M	adult		yes	no	cast
373	M	adult		yes	no	cast
400	M	adult		yes	no	cast
434	M	adult		no	yes	active
443	M	adult		yes	no	cast
448	F	adult	None	yes	yes	active
450	M	adult		yes	yes	active
481	F	adult	None	no	no	cast
492	F	adult	None	yes	no	cast
499	F	adult	2 COY	yes	no	cast
500	F	adult	2 yearlings	yes	no	cast
514	M	adult		no	no	cast
515	M	adult		no	yes	active
520	M	adult		yes	no	cast
525	F	adult	None	yes	yes	active
526	M	adult		no	yes	active
531	F	adult	None	yes	no	cast
532	M	adult		yes	no	cast
533	F	adult	3 COY	yes	yes	active
537	F	adult	3 COY	yes	yes	active
541	F	adult	None	yes	no	cast
547	M	adult		no	no	cast
551	F	adult	None	yes	no	cast
553	M	adult		no	no	cast

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current Status
554	F	subadult		yes	no	killed
556	M	adult		yes	yes	active
565	M	adult		yes	no	cast
567	M	adult		yes	no	cast
568	M	adult		no	no	unresolved
569	F	adult	2 COY	yes	yes	active
570	M	adult		no	yes	active
574	M	adult		yes	no	unresolved
576	F	adult	2 COY, lost 1	yes	no	cast
577	F	adult	None	yes	yes	active
584	M	adult		yes	yes	active
589	M	adult		yes	no	cast
590	F	subadult		yes	yes	active
591	F	subadult		yes	no	cast
592	M	adult		yes	yes	active
593	M	subadult		yes	no	cast
594	M	subadult		yes	no	cast
596	F	adult	None	yes	no	removed
599	M	adult		yes	yes	active
600	M	subadult		yes	no	cast
601	F	subadult		yes	no	battery
602	F	subadult		yes	no	battery
603	M	adult		no	no	cast
604	M	adult		no	yes	active
605	F	subadult		no	yes	active
606	M	adult		no	no	unresolved
607	M	adult		no	no	cast

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current Status
608	M	adult		no	no	cast
609	M	subadult		no	no	cast
610	F	adult		no	yes	active
611	M	adult		no	yes	active
612	F	adult	None	no	no	cast
613	F	adult	None	no	no	missing
614	F	adult	None	no	no	cast
615	F	subadult		no	no	dead
616	F	adult	None	no	no	cast
617	M	subadult		no	yes	active
618	M	subadult		no	yes	active
619	M	subadult		no	yes	active
620	F	adult	None	no	yes	active
621	M	adult		no	no	dead
622	M	subadult		no	yes	active
623	M	subadult		no	yes	active
624	M	adult		no	yes	active
625	M	adult		no	yes	active
626	F	adult	1 yearling	no	yes	active
627	F	adult	3 COY	no	yes	active
628	F	subadult		no	yes	active
629	M	adult		no	no	dead
630	M	adult		no	yes	active
631	F	subadult		no	yes	active
632	M	adult		no	yes	active
633	M	adult		no	yes	active

[a] COY = cub-of-the-year.

Bear #201 captured on 10 Jun 2009. Photos courtesy of Jonathan Ball.

Assessing Trend and Estimating Population Size from Counts of Unduplicated Females *(Mark A. Haroldson, Interagency Grizzly Bear Study Team)*

Methods

Under the Revised Demographic Recovery Criteria (USFWS 2007*b*) of the Grizzly Bear Recovery Plan (USFWS 1993), IGBST is tasked with estimating the number of females with COY, determining trend in this segment of the population, and estimating size of specific population segments to assess sustainability of annual mortalities. The area within which the revised criteria apply for counting females with COY and mortalities is referenced in Figure 1 of the Revised Demographic Criteria (USFWS 2007*b*). However, the area referenced in this figure is incorrect on its western and northern boundaries in Montana and will be corrected with an erratum (Chris Servheen, USFWS Grizzly Bear Recovery Coordinator, personal communication). Specific procedures used to accomplish the above mentioned tasks are presented in IGBST (2005, 2006) and Harris (2007). Briefly, the Knight et al. (1995) rule set is used to differentiate an estimate for the number of unique females with COY ($\hat{N}_{Obs}$) and tabulate sighting frequencies for each family. We then apply the Chao2 estimator (Chao 1989, Wilson and Collins 1992, Keating et al. 2002, Cherry et al. 2007)

$$\hat{N}_{Chao2} = m + \frac{f_1^2 - f_1}{2(f_2 - 1)},$$

where m is the number of unique females sighted randomly (i.e., without the aid of telemetry), f_1 is the number of families sighted once, and f_2 is the number families sighted twice. This estimator accounts for individual sighting heterogeneity and produces an estimate for the total number of female with COY present in the population annually.

Next, we estimate trend and rate of change (λ) for the number of unique females with COY in the population from the natural log (Ln) of the annual $\hat{N}_{Chao2}$ estimates using linear and quadratic regressions with model averaging (Burnham and Anderson 2002). The linear model for $Ln(\hat{N}_{Chao2})$ with year (y_i) is:

$$Ln(\hat{N}_{Chao2}) = \beta_0 + \beta_1 y_i + \varepsilon_i .$$

Thus the population size at time zero is estimated as $\hat{N}_0 = \exp(\hat{\beta}_0)$ and the rate of population change is estimated as $\hat{\lambda} = \exp(\hat{\beta}_1)$, giving $\hat{N}_i = \hat{N}_0 \hat{\lambda}^{y_i}$. The quadratic model:

$$Ln(\hat{N}_{Chao2}) = \beta_0 + \beta_1 y_i + \beta_2 y_i^2 + \varepsilon_i ,$$

is included to detect changes in tend. Model AIC (Akaike Information Criterion) will favor the quadratic model if the rate of change levels off or begins to decline (IGBST 2006, Harris et al. 2007). This process smoothes variation in annual estimates that result from sampling error or pulses in numbers of females producing cubs due to natural processes (i.e., process variation). Some changes in previous model-averaged estimates for unduplicated females with COY ($\hat{N}_{MAFC}$) are expected with each additional year of data. Retrospective adjustments to previous estimates are not done (IGBST 2006). Demographic Recovery Criterion 1 (USFWS 2007*b*) specifies a minimum requirement of 48 females with COY for the current year ($\hat{N}_{MAFC}$). Model-averaged estimates below 48 for 2 consecutive years will trigger a biology and management review, as will a shift in AIC that favors the quadratic model (i.e., AICc weight > 0.50, USFWS 2007*a*).

Given the assumption of a reasonably stable sex and age structure, trend for the females with COY represents the rate of change for the entire population (IGBST 2006, Harris et al. 2007). It follows that estimates for specific population segments can be derived from the $\hat{N}_{MAFC}$ and the estimated stable age structure for the population. Estimates for specific population segments and associated confidence intervals follow IGBST (2005, 2006). Thus, the total number of females ≥2 years old in the population is estimated by

$$\hat{N}_{females\ 2+} = \frac{\hat{N}_{MAFC}}{(0.289 * 0.77699)},$$

where 0.289 is the proportion of females ≥4 years old accompanied by COY from transition probabilities (IGBST 2005), and 0.77699 is the ratio of 4+ female to 2+ females in the population (IGBST 2006). Using the model averaged results in these calculations has the effect of putting the numerator ($\hat{N}_{MAFC}$) on the same temporal scale as the denominator (i.e., mean transition probability and ratio) which smoothes estimates and alleviates extreme variation which are likely uncharacteristic of the true population (IGBST 2006, Harris et al. 2007). The number of independent aged males is given by

$$\hat{N}_{males\ 2+} = \hat{N}_{females\ 2+} * 0.63513\,,$$

where 0.63513 is the ratio of independent males:independent females (IGBST 2006). The number of dependent young is estimated by

$$\hat{N}_{dependent\ young} = \{\hat{N}_{MAFC,\,t} + [(\hat{N}_{MAFC,\,t-1})(0.638)]\}2.04$$

where 2.04 is the mean number of COY/litter (Schwartz et al. 2006*a*) and 0.638 is the mean survival rate for COY (Schwartz et al. 2006*b*). Estimates of uncertainty associated with parameters of interest were derived from the delta method (Seber 1982:7) as described in IGBST (2006).

<u>2009 Results</u>

We documented 117 verified sightings of females with COY during 2009 within the area where the Revised Demographic Criteria apply (Fig. 1). This was very similar to the 118 sightings obtained during 2008. Observations were almost evenly split between ground (53%) and aerial (47%) observers (Table 4). Thirty-two percent of the observations occurred within the boundary of Yellowstone National Park. From the 117 sightings we were able to differentiate 42

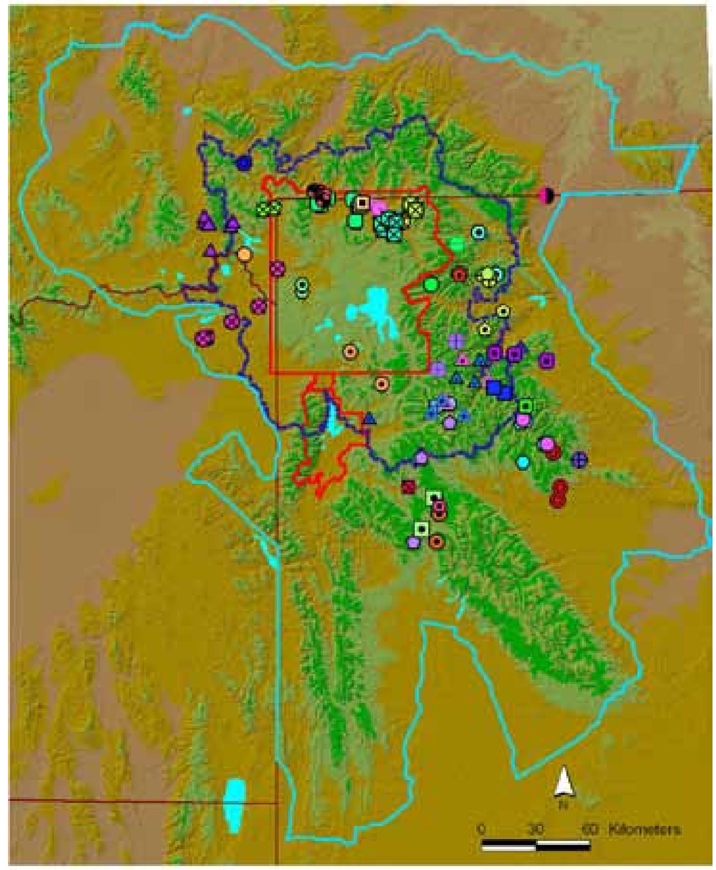


Fig. 1. Distribution of 117 observations of 42 (indicated by unique symbols) unduplicated female grizzly bears with cubs-of-the-year (COY) in the Greater Yellowstone Ecosystem during 2009. The outer light blue line represents the boundary within which females with COY are counted for estimation of trend and population size and mortalities are counted for evaluation of sustainability. The inner dark blue and red boundaries indicate the Yellowstone grizzly bear Recovery Zone and National Park Services lands, respectively.

Table 4. Method of observation for female grizzly bears with cubs-of-the-year sighted in the Greater Yellowstone Ecosystem during 2009.

Method of observation	Frequency	Percent	Cumulative percent
Fixed wing – other researcher	4	3.4	3.4
Fixed wing – observation	34	29.1	32.5
Fixed wing - telemetry	16	13.7	46.2
Ground sighting	62	53.0	99.1
Helicopter – other research	1	0.9	100.0
Trap	0	0.0	100.0
Total	117	100	

Table 5. Number of unduplicated females with cubs-of-the-year ($\hat{N}_{Obs}$), litter frequencies, total number of cubs, and average litter size at initial observation for the years 1973–2009 in the Greater Yellowstone Ecosystem.

Year	$\hat{N}_{Obs}$	Total sightings	Litter sizes: 1 cub	2 cubs	3 cubs	4 cubs	Total # cubs	Mean litter size
1973	14	14	4	8	2	0	26	1.86
1974	15	15	6	7	2	0	26	1.73
1975	4	9	2	2	0	0	6	1.50
1976	17	26	3	13	1	0	32	1.88
1977	13	19	3	8	2	0	25	1.92
1978	9	11	2	4	3	0	19	2.11
1979	13	14	2	6	5	0	29	2.23
1980	12	17	2	9	1	0	23	1.92
1981	13	22	4	7	2	0	24	1.85
1982	11	18	3	7	1	0	20	1.82
1983	13	15	6	5	2	0	22	1.69
1984	17	41	5	10	2	0	31	1.82
1985	9	17	3	5	1	0	16	1.78
1986	25	85	6	15	4	0	48	1.92
1987	13	21	1	8	4	0	29	2.23
1988	19	39	1	14	4	0	41	2.16
1989	16	33	7	5	4	0	29	1.81
1990	25	53	4	10	10	1	58	2.32
1991[a]	24	62	6	14	3	0	43	1.87
1992	25	39	2	12	10	1	60	2.40
1993	20	32	4	11	5	0	41	2.05
1994	20	34	1	11	8	0	47	2.35
1995	17	25	2	10	5	0	37	2.18
1996	33	56	6	15	12	0	72	2.18
1997	31	80	5	21	5	0	62	2.00
1998	35	86	9	17	9	0	70	2.00
1999	33	108	11	14	8	0	63	1.91
2000	37	100	9	21	7	0	72	1.95
2001	42	105	13	22	7	0	78	1.86
2002	52	153	14	26	12	0	102	1.96
2003	38	60	6	27	5	0	75	1.97
2004	49	223	14	23	12	0	96	1.96
2005	31	93	11	14	6	0	57	1.84
2006	47	172	12	21	14	0	96	2.04
2007	50	335	10	22	18	0	108	2.16
2008	44	118	10	28	6	0	84	1.91
2009	42	117	10	19	11	2	89	2.12

[a] One female with unknown number of cubs. Average litter size was calculated using 23 females.

unduplicated females using the rule set described by Knight et al. (1995). Total number of COY observed during initial sightings was 89 and mean litter size was 2.12 (Table 5). There were 10 single cub litters, 19 litters of twins, 11 litters of triplets, and 2 quadruplet litters seen during initial observations (Table 5). Four-cub litters have been observed previously in the GYE but are uncommon (Table 5). There is a possibility that these litters were the result of adoptions (see Haroldson et al. 2008) or mixed age litters (Swenson and Haroldson 2008). However, these possibilities seem unlikely in one of these events that involved a radio-collared female. Female #279 was observed once with 4 small, similar sized COY early in the active season (1 June 2009). Thus there would be limited opportunity for adoption to have occurred. Subsequent observation of female #279 in July and August indicated she had lost 1 of her COY. The other female observed with 4 COY was only observed once on 4 August 2009.

One-hundred observations of 39 families were obtained without telemetry (Table 6). Using the sighting frequencies associated with these families our 2009 $\hat{N}_{Chao2}$ = 44 (Table 6). Annual $\hat{N}_{Chao2}$ for the period 1983–2009 (Table 6) were used to estimate the rate of population change (Fig. 2). Parameter estimates and AICc weights for the linear and quadratic models (Table 7) suggest that the linear model was the better fit for the period, with 63% of the AICc weight. The estimated quadratic effect (β_2 = -0.00105, SE = 0.00083) was not significant (*P* = 0. 21715), with quadratic model receiving 37% of the AICc weight. Thus, the linear model continues to be better supported (USFWS 2007*b*), indicating an increasing trend. However, evidence for a slowing in the rate of change increased over that observed in 2008 (Haroldson 2009) as indicated by greater weight on the quadratic model (37% in 2009 vs. 26% in 2008). Using the linear model our estimate of $\hat{\lambda}$ for 1983–2009 is 1.04248 (95% CI 1.02999–1.055512). The model averaged point estimate ($\hat{N}_{MAFC}$) is 55 (95% CI 45–67) and exceeds the demographic objective of 48 specified in the demographic criteria for the GYE (USFWS 2007*b*). Our estimated population size for 2009 derived from $\hat{N}_{MAFC}$ is 582 (Table 8).


Bear #360 with 2 cubs-of-the-year, 9 Aug 2009. Photo courtesy of Steve Ard.

Table 6. Annual estimates for the numbers of females with cubs-of-the-year in the Greater Yellowstone Ecosystem grizzly bear population, 1983–2009. The number of unique females observed ($\hat{N}_{Obs}$) includes those located using radio-telemetry; m gives the number of unique females observed using random sightings only; and $\hat{N}_{Chao2}$ gives the nonparametric biased corrected estimate, per Chao (1989). Also included are f_1, the number of families sighted once, f_2, the number of families sighted twice, and an annual estimates of relative sample size ($n/\hat{N}_{Chao2}$), where n is the total number of observations obtained without the aid of telemetry.

Year	$\hat{N}_{Obs}$	m	f_1	f_2	$\hat{N}_{Chao2}$	n	$n/\hat{N}_{Chao2}$
1983	13	10	8	2	19	12	0.6
1984	17	17	7	3	22	40	1.8
1985	9	8	5	0	18	17	0.9
1986	25	24	7	5	28	82	3
1987	13	12	7	3	17	20	1.2
1988	19	17	7	4	21	36	1.7
1989	16	14	7	5	18	28	1.6
1990	25	22	7	6	25	49	2
1991	24	24	11	3	38	62	1.6
1992	25	23	15	5	41	37	0.9
1993	20	18	8	8	21	30	1.4
1994	20	18	9	7	23	29	1.3
1995	17	17	13	2	43	25	0.6
1996	33	28	15	10	38	45	1.2
1997	31	29	13	7	39	65	1.7
1998	35	33	11	13	37	75	2
1999	33	30	9	5	36	96	2.7
2000	37	34	18	8	51	76	1.5
2001	42	39	16	12	48	84	1.7
2002	52	49	17	14	58	145	2.5
2003	38	35	19	14	46	54	1.2
2004	49	48	15	10	58	202	3.5
2005	31	29	6	8	31	86	2.8
2006	47	43	8	16	45	140	3.3
2007	50	48	12	12	53	275	5.1
2008	44	43	16	8	56	102	1.8
2009	42	39	11	11	44	100	2.3

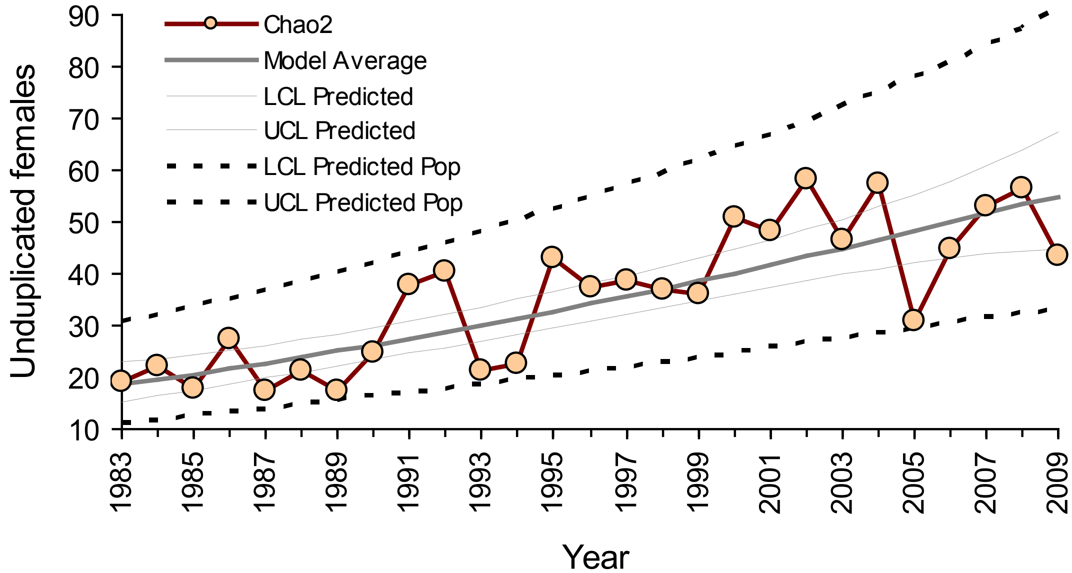


Fig. 2. Model-averaged estimates for the number of unduplicated female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem for the period 1983–2009, where the linear and quadratic models of $Ln(\hat{N}_{Chao2})$ were fitted. The inner set of light solid lines represents a 95% confidence interval on the predicted population size for unduplicated females, whereas the outer set of dashed lines represents a 95% confidence interval for the individual population estimates for unduplicated females.

Table 7. Parameter estimates and model selection results from fitting the linear and quadratic models for $Ln(\hat{N}_{Chao2})$ with years for the period 1983–2009.

Model	Parameter	Estimate	Standard error	*t* value	Pr(>*t*)
Linear					
	β_0	2.92658	0.09375	31.21624	<0.0001
	β_1	0.04160	0.00585	7.10880	<0.0001
	SSE	1.40231			
	AICc	-72.81480			
	AICc weight	0.62544			
Quadratic					
	β_0	2.78392	0.14577	19.09740	<0.0001
	β_1	0.07112	0.02399	2.96381	0.00676
	β_2	-0.00105	0.00083	-1.26746	0.21715
	SSE	1.31434			
	AICc	-71.78943			
	AICc weight	0.37456			

Table 8. Estimates and 95% confidence intervals (CI) for population segments and total grizzly bear population size for 2009 in the Greater Yellowstone Ecosystem.

			95% CI	
	Estimate	Variance	Lower	Upper
Independent females	245	461.2	203	287
Independent males	156	333.5	120	191
Dependent young	181	103.9	162	201
Total	582	898.2	523	641

Occupancy of Bear Management Units by Females with Young *(Shannon Podruzny, Interagency Grizzly Bear Study Team)*

Dispersion of reproductive females throughout the ecosystem is assessed by verified observation of female grizzly bears with young (COY, yearlings, 2-year-olds, and/or young of unknown age) by BMU. The requirements specified in the Revised Demographic Recovery Criteria (USFWS 2007*b*) state that 16 of the 18 BMUs must be occupied by young on a running 6-year sum with no 2 adjacent BMUs unoccupied. Eighteen of 18 BMUs had verified observations of female grizzly bears with young during 2009 (Table 9). Eighteen of 18 BMUs contained verified observations of females with young in at least 4 years of the last 6-year (2004–2009) period.

Table 9. Bear Management Units (BMUs) in the Greater Yellowstone Ecosystem occupied by females with young (cubs-of-the-year, yearlings, 2-year-olds, or young of unknown age), as determined by verified reports, 2004–2009.

Bear Management Unit	2004	2005	2006	2007	2008	2009	Number of years occupied 2004–2009
1) Hilgard	X	X	X	X	X	X	6
2) Gallatin	X	X	X	X	X	X	6
3) Hellroaring/Bear		X	X		X	X	4
4) Boulder/Slough	X	X		X	X	X	5
5) Lamar	X	X	X	X	X	X	6
6) Crandall/Sunlight	X	X	X	X	X	X	6
7) Shoshone	X	X	X	X	X	X	6
8) Pelican/Clear	X	X	X	X	X	X	6
9) Washburn	X	X	X	X	X	X	6
10) Firehole/Hayden	X	X	X	X	X	X	6
11) Madison		X	X	X	X	X	5
12) Henry's Lake	X	X	X	X	X	X	6
13) Plateau	X	X		X	X	X	5
14) Two Ocean/Lake	X	X	X	X	X	X	6
15) Thorofare	X	X	X	X	X	X	6
16) South Absaroka	X	X	X	X	X	X	6
17) Buffalo/Spread Creek	X	X	X	X	X	X	6
18) Bechler/Teton	X	X	X	X	X	X	6
Annual count of occupied BMUs	16	18	16	17	18	18	

Observation Flights *(Karrie West, Interagency Grizzly Bear Study Team)*

Two rounds of observation flights were conducted during 2009. Forty-seven Bear Observation Areas (BOAs; Fig. 3) were surveyed during each round (Round 1: 26 May–17 Jul; Round 2: 8 Jul–27 Aug). Observation time was 90 hours for Round 1 and 94 hours for Round 2; average duration of flights for both rounds combined was 2.0 hours (Table 10).

Three hundred bear sightings, excluding dependent young, were recorded during observation flights. This included 3 radio-marked bears, 243 solitary unmarked bears, and 54 unmarked females with young (Table 10). Observation rate was 1.63 bears/hour for all bears. Ninety-eight young (55 COY, 31 yearlings, and 12 2-year-olds) were observed (Table 11). Observation rates were 0.29 females with young/hour and 0.15 females with COY/hour (Table 10).

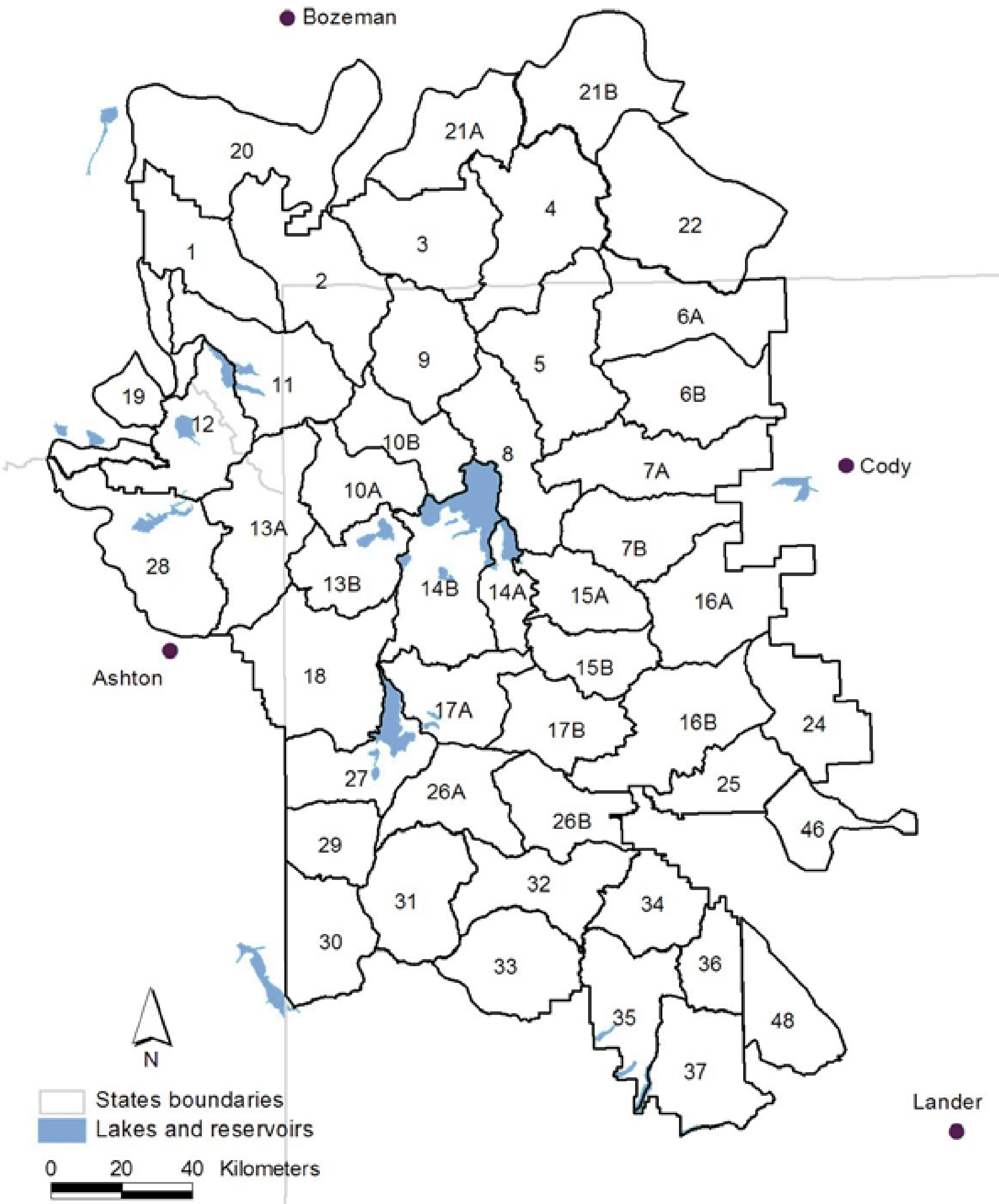


Fig. 3. Observation flight areas within the Greater Yellowstone Ecosystem, 2009. The numbers represent the 38 Bear Observation Areas. Those units too large to search during a single flight were further subdivided into 2 units. Consequently, there were 48 search areas.

Table 10. Annual summary statistics for observation flights conducted in the Greater Yellowstone Ecosystem, 1997–2009.

Date	Observation period	Total hours	Number of flights	Average hours/ flight	Bears seen: Marked Lone	Marked With young	Unmarked Lone	Unmarked With young	Total number of groups	Observation rate (bears/hour): All groups	With young	With COY[a]
1997[b]	Round 1	55.5	26	2.1	1	1	38	19	59	1.08		
	Round 2	59.3	24	2.5	1	1	30	17	49	0.83		
	Total	114.8	50	2.3	2	2	68	36	108	0.94	0.33	0.16
1998[b]	Round 1	73.6	37	2.0	1	2	54	26	83	1.13		
	Round 2	75.4	37	2.0	2	0	68	18	88	1.17		
	Total	149.0	74	2.0	3	2	122	44	171	1.15	0.31	0.19
1999[b]	Round 1	79.7	37	2.2	0	0	13	8	21	0.26		
	Round 2	74.1	37	2.0	0	1	21	8	30	0.39		
	Total	153.8	74	2.1	0	1	34	16	51	0.33	0.11	0.05
2000[b]	Round 1	48.7	23	2.1	0	0	8	2	10	0.21		
	Round 2	83.6	36	2.3	3	0	51	20	74	0.89		
	Total	132.3	59	2.2	3	0	59	22	84	0.63	0.17	0.12
2001[b]	Round 1	72.3	32	2.3	0	0	37	12	49	0.68		
	Round 2	72.4	32	2.3	2	4	85	29	120	1.66		
	Total	144.7	64	2.3	2	4	122	41	169	1.17	0.31	0.25
2002[b]	Round 1	84.0	36	2.3	3	0	88	34	125	1.49		
	Round 2	79.3	35	2.3	6	0	117	46	169	2.13		
	Total	163.3	71	2.3	9	0	205	80	294	1.80	0.49	0.40
2003[b]	Round 1	78.2	36	2.2	2	0	75	32	109	1.39		
	Round 2	75.8	36	2.1	1	1	72	19	93	1.23		
	Total	154.0	72	2.1	3	1	147	51	202	1.31	0.34	0.17
2004[b]	Round 1	84.1	37	2.3	0	0	43	12	55	0.65		
	Round 2	76.6	37	2.1	1	2	94	38	135	1.76		
	Total	160.8	74	2.2	1	2	137	50	190	1.18	0.32	0.23
2005[b]	Round 1	86.3	37	2.3	1	0	70	20	91	1.05		
	Round 2	86.2	37	2.3	0	0	72	28	100	1.16		
	Total	172.5	74	2.3	1	0	142	48	191	1.11	0.28	0.13
2006[b]	Round 1	89.3	37	2.4	2	1	106	35	144	1.61		
	Round 2	77.0	33	2.3	3	1	76	24	104	1.35		
	Total	166.3	70	2.3	5	2	182	59	248	1.49	0.37	0.27
2007[b]	Round 1	99.0	44	2.3	2	1	125	53	181	1.83		
	Round 2	75.1	30	2.5	0	4	96	20	120	1.60		
	Total	174.1	74	2.4	2	5	221	73	301	1.73	0.45	0.29
2008[b]	Round 1	97.6	46	2.1	2	1	87	36	126	1.29		
	Round 2	101.5	45	2.3	2	3	185	53	243	2.39		
	Total	199.1	91	2.2	4	4	272	89	369	1.85	0.47	0.23
2009[b]	Round 1	90.3	47	1.9	1	0	86	20	107	1.19		
	Round 2	93.6	47	2.0	2	0	157	34	193	2.06		
	Total	183.9	94	2.0	3	0	243	54	300	1.63	0.29	0.15

[a] COY = cub-of-the-year.

[b] Dates of flights (Round 1, Round 2): 1997 (24 Jul–17 Aug, 25 Aug–13 Sep); 1998 (15 Jul–6 Aug, 3–27 Aug); 1999 (7–28 Jun, 8 Jul–4 Aug); 2000 (5–26 Jun, 17 Jul–4 Aug); 2001 (19 Jun–11 Jul, 16 Jul–5 Aug); 2002 (12 Jun–22 Jul, 13 Jul–28 Aug); 2003 (12 Jun–28 Jul, 11 Jul–13 Sep); 2004 (12 Jun–26 Jul, 3 Jul–31 Aug); 2005 (4 Jun–26 Jul, 1 Jul–31 Aug); 2006 (5 Jun–9 Aug, 30 Jun–28 Aug); 2007 (24 May–2 Aug, 21 Jun–14 Aug); 2008 (12 Jun–26 Jul, 1 Jul–23 Aug); 2009 (26 May–17 Jul, 8 Jul–27 Aug).

Table 11. Size and age composition of family groups seen during observation flights in the Greater Yellowstone Ecosystem, 1998–2009.

Date	Females with cubs-of-the-year (number of cubs)			Females with yearlings (number of yearlings)			Females with 2-year-olds or young of unknown age (number of young)		
	1	2	3	1	2	3	1	2	3
1998[a]									
Round 1	4	10	4	0	4	2	1	2	1
Round 2	0	7	3	2	4	1	0	1	0
Total	4	17	7	2	8	3	1	3	1
1999[a]									
Round 1	2	1	1	0	1	2	1	0	0
Round 2	2	2	0	0	3	1	0	1	0
Total	4	3	1	0	4	3	1	1	0
2000[a]									
Round 1	1	0	0	0	0	0	0	1	0
Round 2	3	11	1	1	2	0	0	2	0
Total	4	11	1	1	2	0	0	3	0
2001[a]									
Round 1	1	8	1	1	0	0	0	0	1
Round 2	14	10	2	4	2	1	0	0	0
Total	15	18	3	5	2	1	0	0	1
2002[a]									
Round 1	8	15	5	3	2	0	0	0	1
Round 2	9	19	9	2	4	2	0	1	0
Total	17	34	14	5	6	2	0	1	1
2003[a]									
Round 1	2	12	2	2	6	2	3	3	0
Round 2	2	5	3	2	5	0	2	0	1
Total	4	17	5	4	11	2	5	3	1
2004[a]									
Round 1	4	1	3	1	1	0	2	0	0
Round 2	6	16	7	4	7	0	0	0	0
Total	10	17	10	5	8	0	2	0	0
2005[a]									
Round 1	5	5	3	2	3	1	0	1	0
Round 2	4	4	1	3	6	3	5	2	0
Total	9	9	4	5	9	4	5	3	0
2006[a]									
Round 1	8	12	7	4	2	2	1	0	0
Round 2	5	11	2	2	1	0	2	2	0
Total	13	23	9	6	3	2	3	2	0
2007[a]									
Round 1	7	21	9	8	6	0	2	1	0
Round 2	2	6	6	3	2	3	0	2	0
Total	9	27	15	11	8	3	2	3	0
2008[a]									
Round 1	3	10	0	9	5	2[b]	6	2	0
Round 2	9	21	3	7	8	3	3	2	0
Total	12	31	3	16	13	5	9	4	0
2009[a]									
Round 1	0	6	4	2	3	1	3	1	0
Round 2	6	11	1	3	7	1	4	1	1
Total	6	17	5	5	10	2	7	1	1

[a] Dates of flights (Round 1, Round 2): 1998 (15 Jul–6 Aug, 3–27 Aug); 1999 (7–28 Jun, 8 Jul–4 Aug); 2000 (5–26 Jun, 17 Jul–4 Aug); 2001 (19 Jun–11 Jul, 16 Jul–5 Aug); 2002 (12 Jun–22 Jul, 13 Jul–28 Aug); 2003 (12 Jun–28 Jul, 11 Jul–13 Sep); 2004 (12 Jun–26 Jul, 3 Jul–31 Aug); 2005 (4 Jun–26 Jul, 1 Jul–31 Aug); 2006 (5 Jun–9 Aug, 30 Jun–28 Aug); 2007 (24 May–2 Aug, 21 Jun–14 Aug); 2008 (12 Jun–26 Jul, 1 Jul–23 Aug); 2009 (26 May–17 Jul, 8 Jul–27 Aug).
[b] Includes 1 female with 4 yearlings.

Telemetry Relocation Flights *(Karrie West, Interagency Grizzly Bear Study Team)*

Ninety-six telemetry relocation flights were conducted during 2009, resulting in 335.5 hours of search time (ferry time to and from airports excluded) (Table 12). Flights were conducted at least once during all months, with 80% occurring May-November. During telemetry flights, 804 locations of bears equipped with radio transmitters were collected, 78 (10%) of which included a visual sighting. Twenty-five sightings of unmarked bears were also obtained during telemetry flights, including 23 solitary bears, 1 female with a COY, and 1 female with a yearling. Rate of observation for all unmarked bears during telemetry flights was 0.07 bears/hour. Rate of observing females with COY was 0.003/hour, which was considerably less than during observation flights (0.15/hour) in 2009.

In addition to the regular telemetry relocation flights, IGBST conducted weekly flights primarily to locate grizzly and black bears fitted with Global Positioning System collars equipped with spread-spectrum technology (SST) (see *Appendix A*). These flights are not included as routine telemetry because of the additional time required to interrogate collars and download data. From these 17 flights, we collected 60 locations (13 included a visual sighting) from 9 grizzly bears that were part of our regular monitoring sample and 146 locations (11 with a visual sighting) from 13 grizzly bears that were part of the SST project.

Bear 543 swimming in South Arm, Yellowstone Lake, 12 Oct 2006. Photo courtesy of Steve Ard.

Table 12. Summary statistics for radio-telemetry relocation flights in the Greater Yellowstone Ecosystem, 2009.

				Radioed bears			Unmarked bears observed					
								Females			Observation rate (groups/hour)	
Month	Hours	Number of flights	Mean hours per flight	Number of locations	Number seen	Observation rate (groups/hr)	Lone bears	With COY[a]	With yearlings	With young	All groups	Females with COY
January	10.99	3	3.66	49	0	0.00	0	0	0	0	---	---
February	9.18	3	3.06	47	0	0.00	0	0	0	0	---	---
March	13.39	4	3.35	59	1	0.07	0	0	0	0	---	---
April	18.07	5	3.61	54	11	0.61	4	0	0	0	0.22	0.000
May	36.87	11	3.35	77	21	0.57	2	0	0	0	0.05	0.000
June	47.30	15	3.15	78	23	0.49	8	0	0	0	0.17	0.000
July	38.91	11	3.54	68	5	0.13	4	1	1	0	0.15	0.026
August	32.24	10	3.22	71	11	0.34	5	0	0	0	0.16	0.000
September	40.09	10	4.01	80	0	0.00	0	0	0	0	---	---
October	31.12	8	3.89	85	3	0.10	0	0	0	0	---	---
November	43.76	12	3.65	106	3	0.07	0	0	0	0	---	---
December	13.55	4	3.39	30	0	0.00	0	0	0	0	---	---
Total	335.47	96	3.49	804	78	0.23	23	1	1	0	0.07	0.003

[a] COY = cub-of-the-year.

Estimating Sustainability of Annual Grizzly Bear Mortalities *(Mark A. Haroldson, Interagency Grizzly Bear Study Team; and Kevin Frey, Montana Fish, Wildlife and Parks)*

Under the Revised Demographic Recovery Criteria (USFWS 2007*b*) of the Grizzly Bear Recovery Plan (USFWS 1993), IGBST is tasked with evaluating the sustainability of annual grizzly bear mortalities that occur within the boundary shown in Fig. 1 (see *Assessing trend and estimating population size from counts of unduplicated females*). Specific procedures used to accomplish these tasked are presented in IGBST (2005, 2006). Briefly, estimates for specific population segments are derived from the modeled-averaged annual Chao2 estimate for females with COY (see *Assessing trend and estimating population size from counts of unduplicated females*).

Sustainable mortality for independent aged (≥2 years) females is considered 9% of the estimated size for this segment of the population (IGBST 2005, 2006; USFWS 2007*b*). Thus, female mortalities are within sustainable limits if,

$$\hat{D}_F \leq \hat{N}_F * 0.09 ,$$

where, $\hat{N}_F$ is the estimated population size for independent aged females and $\hat{D}_F$ is the estimated total mortality for independent aged females. All sources of mortality are used to evaluate sustainability for independent aged bears, which included an estimate of the unreported loss (Cherry et al. 2002, IGBST 2005). Thus,

$$\hat{D}_F = A_F + R_F + \hat{B}_F , \quad (1)$$

where A_F is the number of sanctioned agency removals of independent females (including radio-marked individuals), R_F is the number of radio-marked bears lost (excluding sanctioned removals), and B_F is the median of the creditable interval for the estimated reported and unreported loss (Cherry et al. 2002).

Sustainability for independent aged males is 15% of the estimated male population (IGBST 2005, 2006; USFWS 2007*b*). Male mortality is considered sustainable if,

$$\hat{D}_M \leq \hat{N}_M * 0.15 ,$$

where $\hat{N}_M$ is the estimated population size for independent aged males and $\hat{D}_M$ is the estimated total mortality for independent males obtained by,

$$\hat{D}_M = A_M + R_M + \hat{B}_M , \quad (2)$$

where A_M is the number of sanctioned agency removals of independent males (including radio-marked individuals), R_M is the number of radio-marked bears lost (excluding sanctioned removals), and B_M is the median of the creditable interval for the estimated reported and unreported loss (Cherry et al. 2002).

Sustainability for dependent young (i.e., COY and yearlings) is set at 9% of the estimate for this population segment. Only human-caused deaths are assessed against this threshold (USFWS 2007*b*).

We continue to use the definitions provided in Craighead et al. (1988) to classify grizzly bear mortalities in the GYE relative to the degree of certainty regarding each event. Those cases in which a carcass is physically inspected or when a management removal occurs are classified as "known" mortalities. Those instances where evidence strongly suggests a mortality has occurred but no carcass is recovered are classified as "probable." When evidence is circumstantial, with no prospect for additional information, a "possible" mortality is designated. Possible mortalities are excluded from assessments of sustainability. We continue to tabulate possible mortalities because at the least they provide an additional source of location information for grizzly bears in the GYE.

2009 Mortality Results

We documented 31 known and probable mortalities in the GYE during 2009, 24 were attributable to human causes (Table 13) and 6 of the reported losses remain under investigation by USFWS and state law enforcement agencies. Specific information related to these 6 mortalities is not provided because of on going investigations. However, these events are included in the following summary. Thirteen (45%) of the human-caused losses were hunting related; including 3 mistaken identity kills by black bear hunters and 6 losses from self-defense kills, 2 of which were adult females accompanied by 4 COY. One of the alleged self-defense kills involving a subadult female bear was ruled unwarranted and was subsequently considered an illegal mortality. The remaining human-caused losses were management removals ($n = 4$), road kills ($n = 2$), and self-defense ($n = 2$). One of the bears killed in self-defense was a female with 3 COY. The COY were subsequently captured and sent to the Memphis Zoo. We also documented 4 natural mortalities and 3 from undetermined causes (Table 13). The natural mortalities included 2 individuals killed by other bears and 2 probable COY losses from radioed females (Table 13).

Among known and probable losses for independent aged female bears there was 1 management removal, 2 deaths of radio-marked bears, and 7 other reported losses (Table 14). The management removal of bear #596 (Table 13, Unique 200928) occurred outside the boundary for counting mortalities under the Revised Demographic Criteria and as such was not counted against the 2009 mortality threshold for independent females. We documented 3 management removals, 2 radio-marked losses, and 6 reported losses for independent aged males (Table 2). Human-caused losses of dependent young totaled 8 (Table 14). Using the criteria specified under the Revised Demographic Recovery Criteria (USFWS 2007*b*) and methodology presented by IGBST (2005, 2006), estimates of total mortality of independent females and males were within sustainable limits for 2009, as were human-caused mortalities of dependent young (Table 14).

Table 13. Grizzly bear mortalities documented in the Greater Yellowstone Ecosystem during 2009.

Unique	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Certainty	Cause
200901	G135	M	adult	5/12/2009	Buffalo Fork, Pr-WY	Known	Human-caused, management removal for nuisance activity in subdivision
200902	Unm	M	subadult	5/24/2009	Newton Cr, SNF, WY	Known	Human-caused, mistaken identity kill by black bear hunter
200903	G142	M	adult	6/11/2009	Blaine Cr, Pr-WY	Known	Human-caused, management removal for repeated cattle depredation.
200904	Unm	M	adult	6/10/2009	N Fork Shoshone River, SNF	Known	Natural, likely killed by another bear
200905	Unm	M	subadult	5/26/2009	Big Thumb Cr, YNP, WY	Known	Natural, died of wounds from fight with another bear
200906	Unm	M	COY	6/9/2009	S Fork Shoshone River, Pr-WY	Known	Human-caused, road kill, mother and 1 sibling COY not injured
200907	Unm	F	adult	6/15/2009	Moose Cr, GNF, MT	Known	Human-caused, defense of life while black bear hunting
200908	270	F	adult	7/19/2009	Line Cr, BLM, WY	Known	Human-caused, self defense kill, human-injuries, 3 COY that accompanied female were captured and removed
200909	Unm	F	COY	7/19/2009	Line Cr, BLM, WY	Known	Human-caused, live removal of female COY of bear #270
200910	Unm	M	COY	7/19/2009	Line Cr, BLM, WY	Known	Human-caused, live removal of male COY of bear #270
200911	Unm	M	COY	7/19/2009	Line Cr, BLM, WY	Known	Human-caused, live removal of male COY of bear #270
200912	475	M	adult	July 2009	Yellowstone River, MT	Known	Undetermined cause, fisherman reported reading ear tags which identified bear #475 on a dead bear observed floating in the Yellowstone River. Carcass was found and recovered on 9/25
200913	Unm	F	subadult	7/25/2009	Twilight Cr, SNF, WY	Known	Human-caused, defense of life

Table 13. Continued.							
Unique	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Certainty	Cause
200914	Unm	F	adult	2009	SNF, WY	Known	Human-caused, under investigation, 2 COY at side
200915	Unm	U	COY	2009	SNF, WY	Probable	Human-caused, COY of female killed, under investigation
200916	Unm	U	COY	2009	SNF, WY	Probable	Human-caused, COY of female killed, under investigation
200917	554	F	subadult	8/26/2009	Deadman Cr, SNF, WY	Known	Human-caused, mistaken identity kill by black bear archery hunter.
200918	Unm	M	adult	9/1/2009	Cedar Cr, Pr-MT	Known	Human-caused, road kill
200919	615	F	subadult	9/19/2009	Ditch Cr, BTNF, WY	Known	Human-caused, unwarranted kill by hunter
200920	Unm	M	adult	9/22/2009	E Fork Pilgrim Cr, BTNF, WY	Known	Human-caused, self-defense kill by hunter
200921	Unm	M	adult	10/6/2009	Pacific Cr, BTNF, WY	Known	Human-caused, management removal for property damage and food rewards
200922	621	M	adult	10/10/2009	Clark's Fork River, GNF, MT	Known	Human-caused, self-defense by hunters
200923	Unm	F	adult	10/14/2009	Jones Cr, SNF, WY	Known	Human-caused, self-defense kill by hunter retireveing harvested elk carcass, 2 COY at side
200924	Unm	U	COY	10/14/2009	Jones Cr, SNF, WY	Probable	Human-caused, COY of female killed by hunter retrieving elk
200925	Unm	U	COY	10/14/2009	Jones Cr, SNF, WY	Probable	Human-caused, COY of female killed by hunter retrieving elk
200926	629	M	adult	2009	CTNF, ID	Known	Human-caused, under investigation
200927	Unm	F	subadult	2009	SNF, WY	Known	Undetermined cause, under investigation
200928	596	F	adult	11/10/2009	Shoshone River, BR-WY	Known	Human-caused, management removal for continued close association to residential area and previous conflict history
200929	Unm	F	adult	2009	SNF, WY	Known	Undetermined cause, under investigation
200930	Unm	U	COY	6/10/2009	Stephens Cr, YNP, MT	Probable	Natural. Radioed female grizzly bear #576 lost 1 of 2 COY between 6/5 and 6/15. Location and mortality date are approximated
200931	Unm	U	COY	7/13/2009	Sheridan Cr, SNF	Probable	Natural. Radioed female grizzly bear #279 lost 1 of 4 COY between 6/1 and 8/25. Location and mortality date are approximated

[a] Unm = unmarked bear; number indicates bear number.
[b] U = sex unknown.
[c] COY = cub-of-the-year, Unk = unknown age.
[d] BLM = Bureau of Land Management, BR = Bureau of Reclamation, BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, YNP = Yellowstone National Park, Pr = private.

Table 14. Annual size estimates ($\hat{N}$) for population segments and evaluation of sustainability for known and probable mortalities documented during 2009 within the boundaries specified in an erratum for the Revised Demographic Criteria (see *Assessing trend and estimating population size from counts of unduplicated females*). Established mortality thresholds (USFWS 2007) are 9%, 9%, and 15% for dependent young and independent (≥2) females and males, respectively. Only human-caused losses are counted against the mortality threshold for dependent young.

Population segment	$\hat{N}$	Human-caused loss	Sanctioned removals (A[a])	Radio-marked loss (R[b])	Reported loss	Estimated reported and unreported loss (B[c])	Estimated total mortality (D[d])	Annual mortality limit	Mortality threshold year result
Dependent young	181	8						16	Under
Independent females[e]	245	8	0	2	7	18	20	22	Under
Independent males[f]	156	8	3	2	6	15	20	24	Under

[a] Term A in equation 1 and 2 is the annual count of agency sanctioned management removals of independent aged bears including those involving radio-marked individual.
[b] Term R in equation 1and 2 is the annual count of loss for independent aged bears wearing active telemetry except those removed through management actions.
[c] Term B in equation 1 and 2 is the median of the credible interval for estimated reported and unreported loss calculated using methods described in Cherry et al. (2002) from the annual reported loss.
[d] Term D in equation 1 and 2, the estimated total mortality, is the sum of the sanctioned removals, the radioed-marked loss, and the estimated reported and unreported loss.
[e] Mortality counts and estimates for independent aged females bears are indicated by subscript F in equation 1.
[f] Mortality counts and estimates for independent aged males bears are indicated by subscript M in equation 2.

In Jul 2009, a dead grizzly bear was observed floating in the Yellowstone River. Ear tags identified it as bear #475. The carcss was found and recovered in Sep 2009. Photo courtesy of Montana Fish, Wildlife and Parks.

Key Foods Monitoring

Spring Ungulate Availability and Use by Grizzly Bears in Yellowstone National Park. *(Shannon Podruzny, Interagency Grizzly Bear Study Team; and Kerry Gunther and Travis Wyman, Yellowstone National Park)*

It is well documented that grizzly bears use ungulates as carrion (Mealey 1980, Henry and Mattson 1988, Green 1994, Blanchard and Knight 1996, Mattson 1997) in Yellowstone National Park. Competition with recently reintroduced wolves (*Canis lupus*) for carrion and changes in bison (*Bison bison*) and elk (*Cervus elaphus*) management policies in the GYE have the potential to affect carcass availability and use by grizzly bears. For these and other reasons, we continue to survey historic carcass transects in Yellowstone National Park. In 2009, we surveyed routes in ungulate winter ranges to monitor the relative abundance of spring ungulate carcasses (Fig. 4).

We surveyed each route once for carcasses between April and early-May. At each carcass, we collected a site description (i.e., location, aspect, slope, elevation, distance to road, distance to forest edge), carcass data (i.e., species, age, sex, cause of death), and information about animals using the carcasses (i.e., species, percent of carcass consumed, scats present). We were unable to calculate the biomass consumed by bears, wolves, or other unknown large scavengers with our survey methodology.

In 2009, we recorded 53 ungulate carcasses for a total of 0.21 carcasses/km surveyed (Fig. 5).

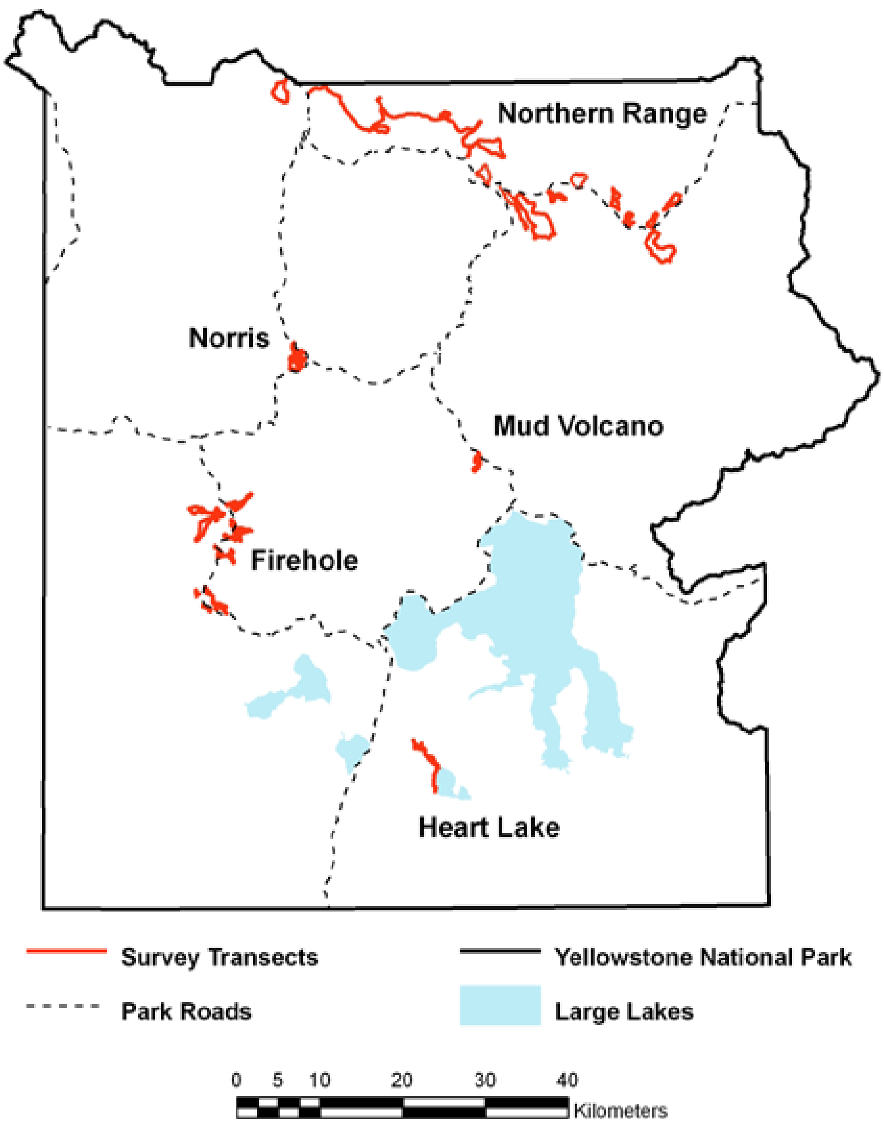


Fig. 4. Spring ungulate carcass survey transects in 5 areas of Yellowstone National Park.

Northern Range

We surveyed 12 routes on Yellowstone's Northern Range totaling 140.6 km traveled. One route was not surveyed to avoid disturbing an active wolf den. We used a GPS to more accurately measure the actual distance traveled on most of the routes. We counted 45 carcasses, including 1 mule deer, 38 elk, 4 bison, and 2 pronghorn, which equated to 0.32 carcasses/km (Table 15). Sex and age of carcasses found are shown in Table 16. All carcasses were almost completely consumed by scavengers. Evidence of use by grizzly bears was found at 1 bison carcass. Evidence of use by wolves was found at 2 elk carcasses. Grizzly bear sign (e.g., tracks, scats, daybeds, or feeding activity) was observed along 8 of the routes. Crews logged sightings of a female with yearlings and 2 other individual grizzlies during the surveys. A black

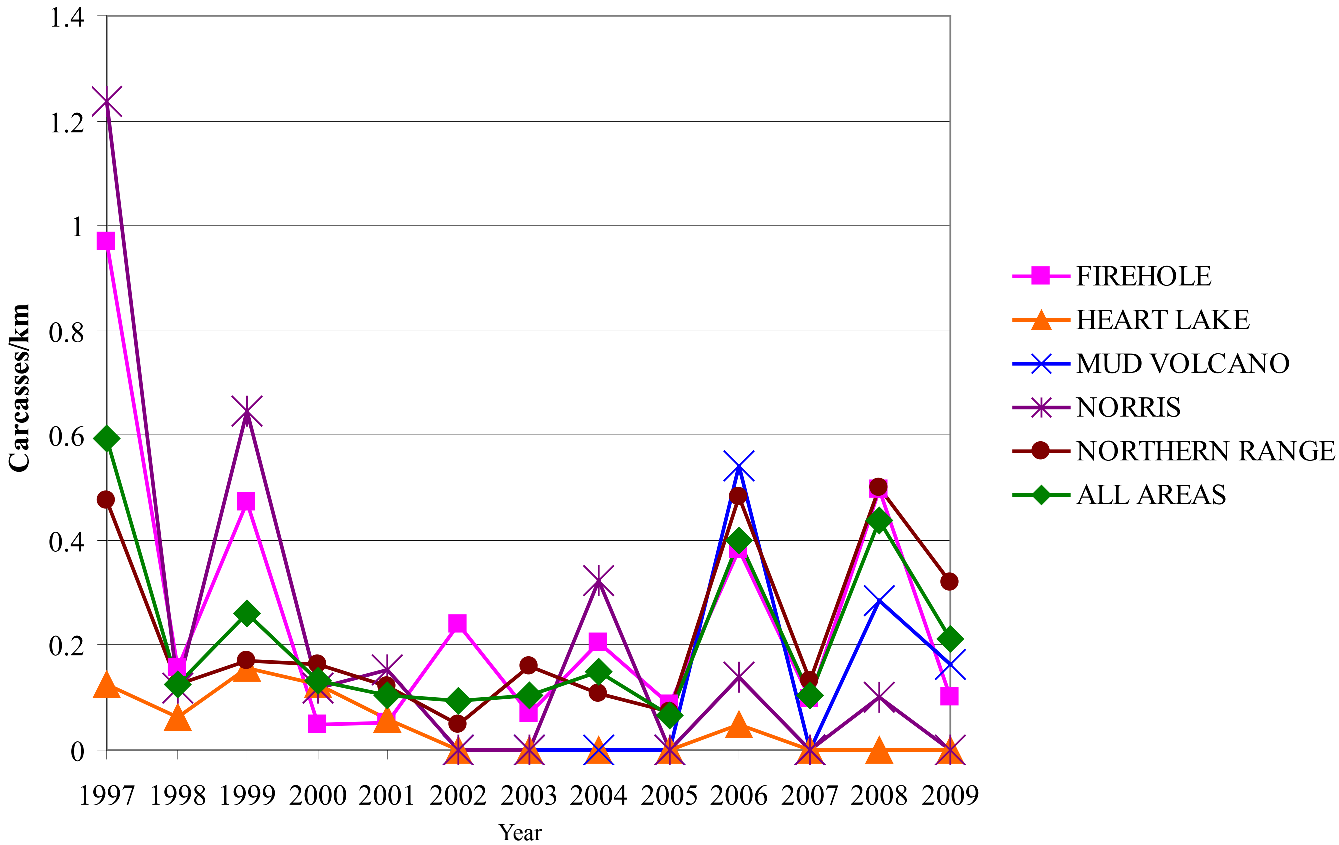


Fig. 5. Annual ungulate carcasses/km found on spring survey routes in winter ranges of Yellowstone National Park, 1997–2009.

bear (*Ursus americanus*) was observed during the Specimen Ridge survey and evidence of black bear use was seen along 3 other routes. The carcass of 1 coyote was also found near an elk carcass.

Firehole River Area

We surveyed 8 routes in the Firehole drainage totaling 69.4 km. We found the remains of 6 bison and 1 elk, which equated to 0.1 carcasses/km traveled (Table 15). Definitive evidence of use by grizzly bears was found at 2 bison carcasses. Grizzly bear sign was also found along all of the routes, and 1 small grizzly was observed. Wolf sign was found at 1 bison carcass

Norris Geyser Basin

We surveyed 4 routes in the Norris Geyser Basin totaling 19.8 km traveled. We observed no carcasses on these transect, but grizzly bear sign was observed along all 4 routes.

Heart Lake

We surveyed 3 routes in the Heart Lake thermal basin covering 13.4 km. We observed no carcasses. Grizzly bear sign, including tracks, scats, and other feeding activities, was observed on all 3 routes. Two individual grizzlies were observed grazing.

Mud Volcano

We surveyed a single route in the Mud Volcano area covering 6.1 km. One bison carcass was observed this spring (0.2 carcasses/km), and tracks and evidence of feeding by at least 1 grizzly bear was found at the carcass. Consumption of mineral soil by grizzly bears was again documented along the route.

Table 15. Ungulate carcasses found and visitation of carcasses by bears, wolves, and unknown large scavengers along surveyed routes in Yellowstone National Park during spring 2009.

	Elk				Bison				
	Number of carcasses	# Visited by species			Number of carcasses	# Visited by species			
Survey area (# routes)		Bear	Wolf	Unknown		Bear	Wolf	Unknown	Total carcasses/km
Northern Range (12)	38	6	2	29	4	2	0	1	0.32[a]
Firehole (8)	1	0	0	1	6	3	1	4	0.10
Norris (4)	0	0	0	0	0	0	0	0	0.00
Heart Lake (3)	0	0	0	0	0	0	0	0	0.00
Mud Volcano (1)	0	0	0	0	1	1	0	0	0.20

[a] Included 2 pronghorn and 1 mule deer carcass.

Table 16. Age classes and sex of elk and bison carcasses found, by area, along surveyed routes in Yellowstone National Park during spring 2009.

	Elk (n = 39)						Bison (n = 11)					
	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total
Age												
Adult	32	1	0	0	0	33	4	3	0	0	1	8
Yearling	3	0	0	0	0	3	0	0	0	0	0	0
Calf	0	0	0	0	0	0	0	2	0	0	0	2
Unknown	3	0	0	0	0	3	0	1	0	0	0	1
Sex												
Male	15	0	0	0	0	15	2	1	0	0	1	4
Female	15	1	0	0	0	16	2	2	0	0	0	4
Unknown	8	0	0	0	0	8	0	3	0	0	0	3

Spawning Cutthroat Trout *(Kerry A. Gunther, Todd M. Koel, Patrick Perrotti, and Eric Reinertson, Yellowstone National Park)*

In the past, spawning cutthroat trout were commonly consumed by grizzly bears that had home ranges adjacent to Yellowstone Lake (Mealey 1975, Reinhart and Mattson 1990, Haroldson et al. 2005). The availability of cutthroat trout around the lake influenced the distribution of bears over a large geographic area (Mattson and Reinhart 1995). In the 1970s and 1980s, grizzly bears were known to prey on cutthroat trout in at least 36 different tributary streams of the lake (Hoskins 1975, Reinhart and Mattson 1990). Haroldson et al. (2005) estimated that approximately 68 grizzly bears likely visited the vicinity of Yellowstone Lake tributary streams annually during the late 1990s. Bears also occasionally prey on cutthroat trout in other areas of the park, including the cutthroat trout (and/or cutthroat x rainbow trout [*Oncorhynchus mykiss*] hybrids) of the inlet creek to Trout Lake located in the northeast section of the park.

Non-native lake trout (*Salvelinus namaycush*) and whirling disease caused by an exotic parasite (*Myxobolus cerebralis*) have significantly reduced the native cutthroat trout population and associated bear fishing activity (Koel et al. 2005*a*, Koel et al. 2006). Drought may also be contributing to the decline of the Yellowstone Lake cutthroat trout population (Koel et al. 2005*b*). Due to the past use of cutthroat trout as a food source by grizzly bears, and the population decline caused by lake trout, whirling disease, and drought, monitoring of the cutthroat trout population is specified under the Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007c). The cutthroat trout population is monitored annually using counts at a fish trap located on Clear Creek on the east shore of Yellowstone Lake, and through visual stream surveys conducted along North Shore and West Thumb tributaries of the lake (Koel et al. 2005*a*, USFWS 2007c). Visual stream surveys are also conducted along the inlet creek at Trout Lake in the northeast section of the park.

<u>Yellowstone Lake</u>

Fish Trap Surveys.—The number of spawning cutthroat trout migrating upstream are counted most years from a weir with a fish trap located at the mouth of Clear Creek on the east side of Yellowstone Lake (Koel et al. 2005*a*). The fish trap is generally installed in May, the exact date depending on winter snow accumulation, weather conditions, and spring snow melt. Fish are counted by dip netting trout that enter the upstream trap box and/or visually counting trout as they swim through wooden chutes attached to the trap. An electronic fish counter is also periodically used. In 2008, unusually high spring run-off damaged the Clear Creek weir and necessitated its removal, preventing operation of the weir and obtaining an accurate fish count that year. The weir has not yet been reconstructed, so a count of the number of spawning cutthroat trout ascending Clear Creek was not obtained in 2009. Prior to removal of the weir in 2008, the number of trout ascending Clear Creek had declined to very low levels (Fig. 6).

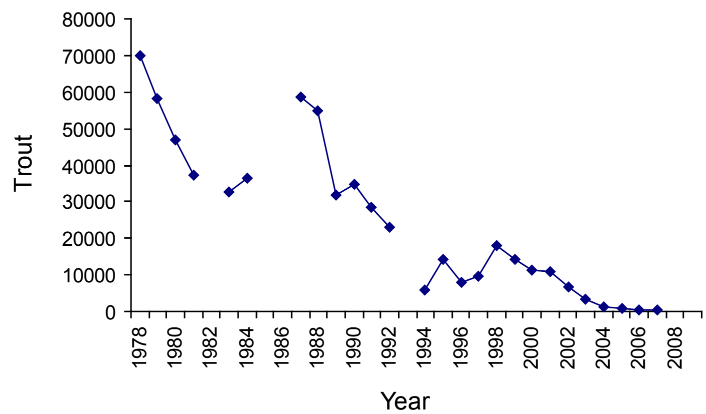


Fig. 6. Number of spawning cutthroat trout counted at the Clear Creek fish trap on the east shore of Yellowstone Lake, Yellowstone National Park, 1977–2009.

Visual Stream Surveys.—Beginning 1 May each year, several streams including Lodge, Hotel, Hatchery, Incinerator, Wells, Bridge, Weasel, and Sand Point Creeks on the North Shore of Yellowstone Lake; and Sandy, Sewer, Little Thumb, and #1167 Creeks in the West Thumb area are checked daily to detect the presence of adult cutthroat trout (Andrascik 1992, Olliff 1992). Once adult trout are found (i.e., onset of spawning), weekly surveys of cutthroat trout in these streams are conducted. Sample methods follow Reinhart (1990), as modified by Andrascik (1992) and Olliff (1992). In each stream on each sample day, 2 people walk upstream from the stream mouth and record the number of adult trout observed. Sampling continues 1 day/week until most adult trout return to the lake (i.e., end of spawning). The length of the spawn is calculated by counting the number of days from the first day spawners are observed through the last day spawners are observed. The average number of spawning cutthroat trout counted per stream survey conducted during the spawning season is used to identify annual trends in the number of cutthroat trout spawning in Yellowstone Lake tributaries.

Data collected in 2009 continued to show low numbers of spawning cutthroat trout in North Shore and West Thumb streams (Table 17). In North Shore streams, only 13 spawning cutthroat trout were counted. Ten spawning trout were counted in Bridge Creek and 3 in Lodge Creek. No spawning cutthroat trout were observed in Hatchery Creek, Incinerator Creek, or Wells Creek. On West Thumb streams, only 62 spawning cutthroat trout were counted including 60 in Little Thumb Creek and 2 in Sandy Creek. No spawning cutthroat trout were observed in Sewer Creek or #1167 Creek. The number of spawning cutthroat trout counted in the North Shore and West Thumb streams has decreased significantly since 1989 (Fig. 7). No evidence of grizzly bear or black bear fishing activity was observed along any of the 9 Yellowstone Lake tributaries surveyed in 2009.

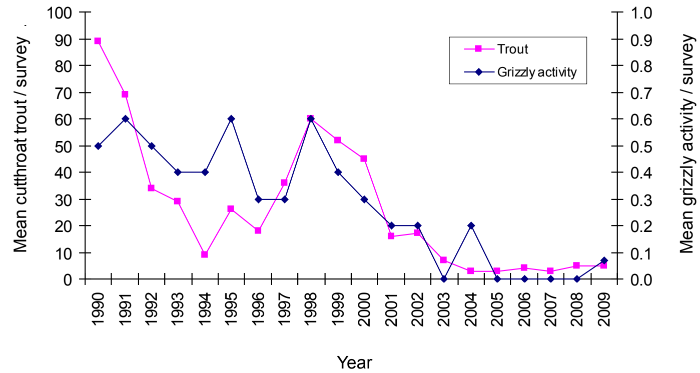


Fig. 7. Mean number of spawning cutthroat trout and mean activity by grizzly bears observed during weekly visual surveys of 5 North Shore and 4 West Thumb spawning streams tributary to Yellowstone Lake, Yellowstone National Park, 1989–2009.

Table 17. Start of spawn, end of spawn, duration of spawn, and average number of spawning cutthroat trout counted per survey in North Shore and West Thumb spawning tributaries to Yellowstone Lake, Yellowstone National Park, 2009.

Stream	Start of spawn	End of spawn	Duration of spawn (days)	Number of surveys during spawning period	Number of fish counted	Average fish/survey
North Shore Streams						
Lodge Creek	6/9	6/30	22	4	3	0.75
Hotel Creek			Not surveyed			
Hatchery Creek			No spawn		0	
Incinerator Creek			No spawn		0	
Wells Creek			No spawn		0	
Bridge Creek	5/26	6/15	21	4	10	2.5
Weasel Creek			Not surveyed			
Sand Point Creek			Not surveyed			
West Thumb Streams						
1167 Creek			No spawn			
Sandy Creek	6/1	6/1	1	1	2	2
Sewer Creek			No spawn			
Little Thumb Creek	6/1	6/30	30	5	60	12
Total (Yellowstone Lake)				14	75	5.4
Northern Range Stream						
Trout Lake Inlet	6/29	7/22	24	4	977	244

Trout Lake

Visual Stream Surveys.—Beginning in mid-May of each year, the Trout Lake inlet creek is checked once per week for the presence of spawning cutthroat trout (and/or cutthroat x rainbow trout hybrids). Once spawning trout are detected (i.e. onset of spawning), weekly surveys of adult trout in the inlet creek are conducted. On each sample day, 2 people walk upstream from the stream mouth and record the number of adult trout observed. Sampling continues 1 day/week until 2 consecutive weeks when no trout are observed in the creek and all trout have returned to Trout Lake (i.e., end of spawn). The length of the spawn is calculated by counting the number of days from the first day spawning trout are observed through the last day spawning trout are observed. The mean number of spawning trout observed per visit is calculated by dividing the total number of adult trout counted by the number of surveys conducted during the spawning period.

In 2009, the first movement of spawning trout from Trout Lake into the inlet creek was observed on 29 June. The spawn lasted approximately 24 days with the last spawning trout being observed in the inlet creek on 22 July. During the once per week visual surveys, 977 spawning cutthroat (and/or cutthroat trout x rainbow trout hybrids) were counted, an average of 244 per visit (Table 17). The number of fish observed per survey has ranged from a low of 31 in 2004, to a high of 266 in 2007 (Fig. 8). No grizzly bears or black bears, bear sign, or evidence of bear fishing activity was observed along the inlet creek during the surveys.

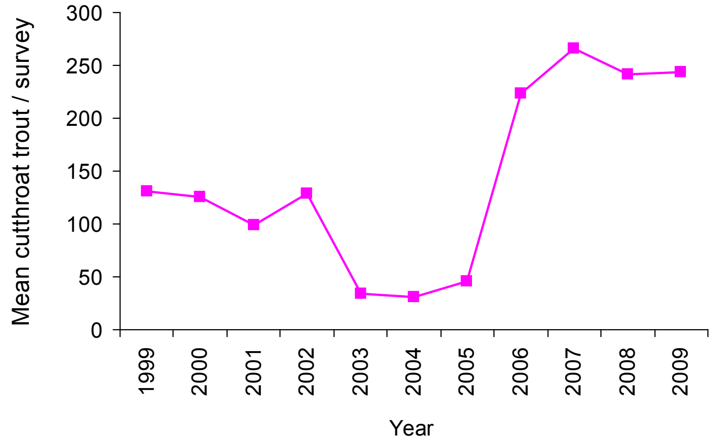


Fig. 8. Mean number of spawning cutthroat (and/or cutthroat x rainbow trout hybrids) observed during weekly visual spawning surveys of the Trout Lake inlet, Yellowstone National Park, 1999–2009.

Cutthroat Trout Outlook.—As part of management efforts to protect the native cutthroat trout population, park fisheries biologists and private-sector (contracted) netters caught and removed 100,758 lake trout from Yellowstone Lake in 2009 (Koel et al. In press). Catch rates are increasing suggesting that lake trout population growth is outpacing the current effort to remove them. The catch per effort of cutthroat trout (unintentional by-catch) in smaller mesh size gillnets used to target juvenile lake trout has more than doubled from the early years of the lake trout removal program, indicating a possible increase in cutthroat trout recruitment in recent years.

Above: Cutthroat trout consumed by lake trout, Lake Trout Removal Program, 2007. Right: Lake trout caught in Yellowstone Lake as part of the Lake Trout Removal Program in 2009. NPS photos.

Grizzly Bear Use of Insect Aggregation Sites Documented from Aerial Telemetry and Observations
(Dan Bjornlie, Wyoming Game and Fish Department; and Mark Haroldson, Interagency Grizzly Bear Study Team)

Army cutworm moths were first recognized as an important food source for grizzly bears in the GYE during the mid 1980s (Mattson et al. 1991*b*, French et al. 1994). Early observations indicated that moths, and subsequently bears, showed specific site fidelity. These sites are generally high alpine areas dominated by talus and scree adjacent to areas with abundant alpine flowers. Such areas are referred to as "insect aggregation sites." Since their discovery, numerous bears have been counted on or near these aggregation sites due to excellent sightability from a lack of trees and simultaneous use by multiple bears.

Complete tabulation of grizzly presence at insect sites is extremely difficult. Only a few sites have been investigated by ground reconnaissance and the boundaries of sites are not clearly known. In addition, it is likely that the size and location of insect aggregation sites fluctuate from year to year with moth abundance and variation in environmental factors such as snow cover.

Since 1986, when insect aggregation sites were initially included in aerial observation surveys, our knowledge of these sites has increased annually. Our techniques for monitoring grizzly bear use of these sites have changed in response to this increase in knowledge. Prior to 1997, we delineated insect aggregation sites with convex polygons drawn around locations of bears seen feeding on moths and buffered these polygons by 500 m. The problem with this technique was that small sites were overlooked due to the inability to create polygons around sites with fewer than 3 locations. From 1997–99, the method for defining insect aggregation sites was to inscribe a 1-km circle around the center of clusters of observations in which bears were seen feeding on insects in talus/scree habitats (Ternent and Haroldson 2000). This method allowed trend in bear use of sites to be annually monitored by recording the number of bears documented in each circle (i.e., site).

A new technique was developed in 2000 (D. Bjornlie, Wyoming Game and Fish Department, personal communication). Using this technique, sites were delineated by buffering only the locations of bears observed actively feeding at insect aggregation sites by 500 m to account for error in aerial telemetry locations. The borders of the overlapping buffers at individual insect sites were dissolved to produce a single polygon for each site. These sites are identified as "confirmed" sites. Because these polygons are only created around feeding locations, the resulting site conforms to the topography of the mountain or ridge top where bears feed and does not include large areas of non-talus habitat that are not suitable for cutworm moths. Locations from the grizzly bear location database from 1 July through 30 September of each year were then overlaid on these polygons and enumerated. The technique to delineate confirmed sites developed in 2000 substantially decreased the number of sites described compared to past years in which locations from both feeding and non-feeding bears were used. Therefore, annual analysis for this report is completed for all years using this technique. Areas suspected as insect aggregation sites but dropped from the confirmed sites list using this technique, as well as sites with only 1 observation of an actively feeding bear or multiple observations in a single year, are termed "possible" sites and will be monitored in subsequent years for additional observations of actively feeding bears. These sites may then be added to the confirmed sites list. When possible sites are changed to confirmed sites, analysis is done on all data back to 1986 to determine the historic use of that site. Therefore, the number of bears using insect aggregation sites in past years may change as new sites are added, and data from this annual report may not match that of past reports. In addition, as new actively feeding bear observations are added to existing sites, the polygons defining these sites increase in size and, thus, more overlaid locations fall within the site. This retrospective analysis brings us closer each year to the "true" number of bears using insect aggregation sites in past years.

In 2009 actively feeding grizzly bears were observed on 2 sites classified as possible in past years. Therefore, these sites were reclassified to confirmed and analysis was done back to 1986. Observations of grizzly bears actively feeding in 2 new areas resulted in the classification of 2 new possible insect aggregation sites. The reclassified sites and new possible sites produced 37 confirmed sites and 15 possible sites for 2009.

The percentage of confirmed sites with documented use by bears varies from year to year, suggesting that some years have higher moth activity than others (Fig. 9). For example, the years 1993–1995 were probably poor moth years because the percentage of confirmed sites used by bears (Fig. 9) and the number of observations recorded at insect sites (Table 18) were low. Overall, the percent of insect aggregation site use by grizzly bears decreased by 3% in 2009 (Fig. 9). The number of observations or telemetry relocations at sites decreased from 2008, as well (Table 18). The number of insect aggregation sites used by bears in 2009 decreased by 1 site to 25 (Table 18) and was slightly higher than the 5-year average of 22.0 sites/year from 2004–2008.

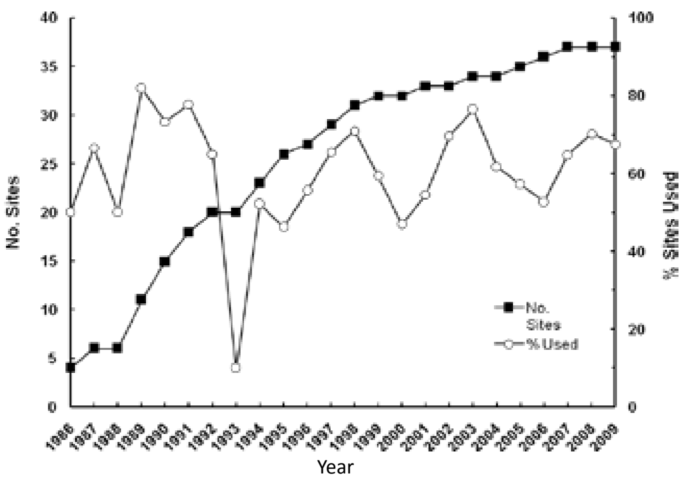


Fig. 9. Annual number of confirmed insect aggregation sites and percent of those sites at which either telemetry relocations of marked bears or visual observations of unmarked bears were recorded, Greater Yellowstone Ecosystem, 1986–2009.

The IGBST maintains an annual list of unduplicated females observed with COY (see Table 4). Since 1986, 768 initial sightings of unduplicated females with COY have been recorded, of which 213 (27%) have occurred at (within 500 m, n = 197) or near (within 1,500 m, n = 16) insect aggregation sites (Table 19). In 2009, 6 of the 42 (14.3%) initial sightings of unduplicated females with COY were observed at insect aggregation sites, a decrease of 5 from 2008 (Table 19) and lower than the 5-year average of 28.8% from 2004–2008.

Survey flights at insect aggregation sites contribute to the count of unduplicated females with COY; however, it is typically low, ranging from 0 to 20 initial sightings/year since 1986 (Table 19). If these sightings are excluded, an increasing trend in the annual number of unduplicated sightings of females with COY is still evident (Fig. 10), suggesting that some other factor besides observation effort at insect aggregation sites is responsible for the increase in sightings of females with cubs.

Table 18. The number of confirmed insect aggregation sites in the Greater Yellowstone Ecosystem annually, the number used by bears, and the total number of aerial telemetry relocations and ground or aerial observations of bears recorded at sites during 1986–2009.

Year	Number of confirmed moth sites[a]	Number of sites used[b]	Number of aerial telemetry relocations	Number of ground or aerial observations
1986	4	2	5	5
1987	6	4	7	8
1988	6	3	12	31
1989	11	9	11	41
1990	15	11	9	75
1991	18	14	11	165
1992	20	13	5	99
1993	20	2	1	1
1994	23	12	1	28
1995	26	12	7	37
1996	27	15	21	66
1997	29	19	17	80
1998	31	22	11	173
1999	32	19	25	155
2000	32	15	39	89
2001	33	18	24	119
2002	33	23	36	238
2003	34	26	10	161
2004	34	21	2	130
2005	35	20	15	175
2006	36	19	19	176
2007	37	24	13	173
2008	37	26	20	212
2009	37	25	8	178
Total			329	2,615

[a] The year of discovery was considered the first year a telemetry location or aerial observation was documented at a site. Sites were considered confirmed after additional locations or observations in a subsequent year and every year thereafter regardless of whether or not additional locations were documented.
[b] A site was considered used if ≥1 location or observation was documented within the site that year.

Table 19. Number of initial sightings of unduplicated females with cubs-of-the-year (COY) that occurred on or near insect aggregation sites, number of sites where such sightings were documented, and the mean number of sightings per site in the Greater Yellowstone Ecosystem, 1986–2009.

Year	Unduplicated females with COY[a]	Number of moths sites with an initial sighting	Initial sightings: Within 500 m[b]		Initial sightings: Within 1,500 m[c]	
			N	%	*N*	%
1986	25	0	0	0.0	0	0.0
1987	13	0	0	0.0	0	0.0
1988	19	1	2	10.5	2	10.5
1989	16	1	1	6.3	1	6.3
1990	25	3	3	12.0	4	16.0
1991	24	8	12	50.0	14	58.3
1992	25	5	7	28.0	9	36.0
1993	20	1	1	5.0	1	5.0
1994	20	3	5	25.0	5	25.0
1995	17	2	2	11.8	2	11.8
1996	33	7	7	21.2	7	21.2
1997	31	8	11	35.5	11	35.5
1998	35	10	13	37.1	13	37.1
1999	33	3	6	18.2	7	21.2
2000	37	6	8	21.6	10	27.0
2001	42	6	12	28.6	13	31.0
2002	52	11	17	32.7	17	32.7
2003	38	11	19	50.0	20	52.6
2004	49	11	16	32.7	16	32.7
2005	31	5	7	22.6	9	29.0
2006	47	11	14	29.8	15	31.9
2007	50	10	17	34.0	17	34.0
2008	44	7	11	25.0	14	31.8
2009	42	4	6	14.3	6	14.3
Total	768		197		213	
Mean	32.0	5.6	8.2	23.0	8.9	25.0

[a] Initial sightings of unduplicated females with COY; see Table 4.
[b] Insect aggregation site is defined as a 500-m buffer drawn around a cluster of observations of bears actively feeding.
[c] This distance is 3 times what is defined as an insect aggregation site for this analysis, since some observations could be made of bears traveling to and from insect aggregation sites.

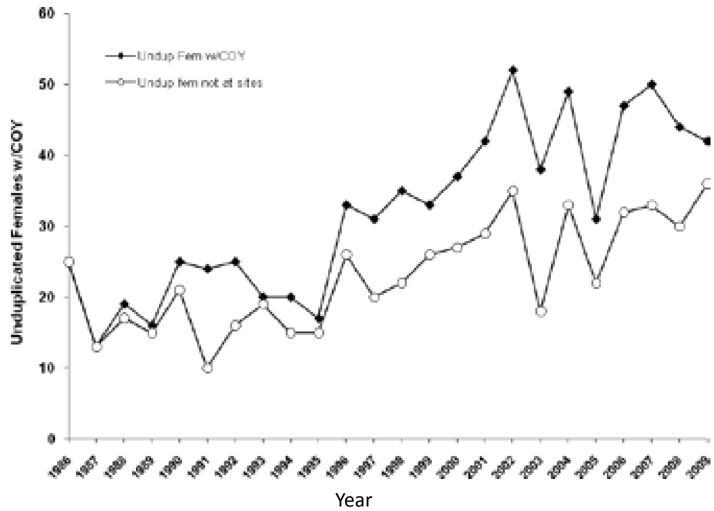


Fig. 10. The total number of unduplicated females with COY observed annually in the Greater Yellowstone Ecosystem and the number of unduplicated females with cubs-of-the-year (COY) not found within 1,500 m of known insect aggregation sites, 1986–2009.

Female with 2 cubs-of-the-year on a moth site, 6 Aug 2004. Photo courtesy of Josh Westerhold.

Whitebark Pine Cone Production *(Mark A. Haroldson and Shannon Podruzny, Interagency Grizzly Bear Study Team)*

Whitebark pine surveys on established transects showed generally good to excellent cone production during 2009 (Fig. 11). Twenty-three transects were read. Overall, mean cones/tree was 46.5 (Table 20, Fig. 12). All trees on transect R were dead and suitable replacement trees could not be found within the stand. This transect will be retired along with 3 that were retired in 2008 (F1, H, and T; Table 21). The best cone production occurred on new transects established during 2007 (CSA-CAG, Fig. 11 and Table 21). Although cones were abundant on most transects, there was a difference (*Student's t* = -4.027, P < 0.0001) in production between old (*n* = 129 trees, mean cone/tree = 27.8) and new (*n* = 63 trees, mean cones/tree = 84.8) transects.

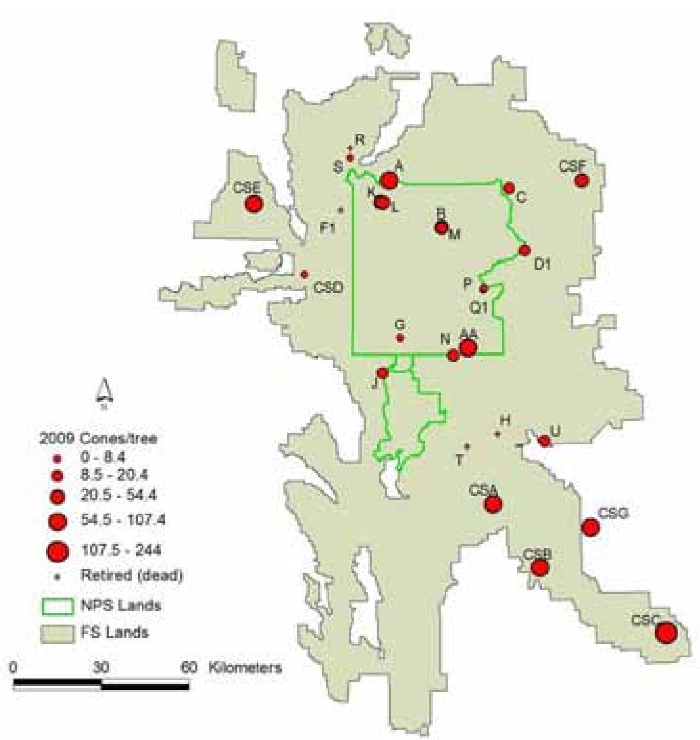


Fig. 11. Locations and mean cones/tree for 26 whitebark pine (*Pinus albicaulis*) cone production transects surveyed in the Greater Yellowstone Ecosystem during 2009.

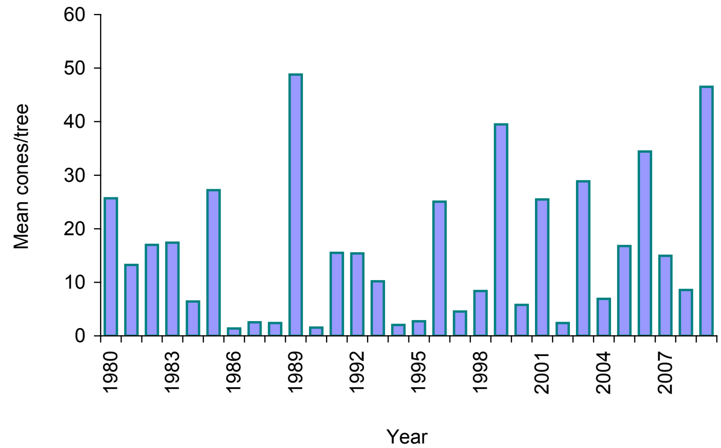


Fig. 12. Annual mean cones/tree on whitebark pine (*Pinus albicaulis*) cone production transects surveyed in the Greater Yellowstone Ecosystem during 1980–2009.

Mountain pine beetle activity continues at high levels on our original 19 transects. We observed additional mortality among trees originally surveyed since 2002. Total mortality on transect trees read since 2002 is 69.5% (132/190) and 94.7% (18/19) of transects contain beetle-killed trees. Five (71.4%) of the 7 new transects exhibited beetle activity.

Near exclusive use of whitebark pine seeds by grizzly bears has been associated with falls in which mean cone production on transects exceeds 20 cones/tree (Blanchard 1990, Mattson et al. 1992). Typically, numbers of grizzly bear-human conflicts and management actions tend to decrease during years with good cone availability. However, extensive areas of beetle-killed whitebark pine may reduce cone abundance and availability locally and may dampen or modify this trend. During August-October 2009, 10 management captures of bears 2-years of age or older (independent) resulted in 9 transports and 1 removal. This result was near the overall average of 9 management actions for August-October, 1980–2008. The number of August-October bear mortalities from self-defense kills by hunters was high (*n* = 6, for independent aged bears (see *Estimating sustainability of annual grizzly bear mortalities*).

Table 20. Summary statistics for whitebark pine (*Pinus albicaulis*) cone production transects surveyed during 2009 in the Greater Yellowstone Ecosystem.

Total			Trees				Transect			
Cones	Trees	Transects	Mean cones	SD	Min	Max	Mean cones	SD	Min	Max
8,928	192	22	46.5	81.7	0	630	405.8	485.2	16	2.193

Table 21. Whitebark pine (*Pinus albicaulis*) cone production transect results for 2009.

Transect	Cones	Trees	Mean	SD
A	704	10	70.4	196.9
B	486	10	48.6	22.5
C	176	9	19.6	11.5
D1	58	5	11.6	7.3
F1		Dead (retired)		
G	53	10	5.3	5.7
H		Dead (retired)		
J	198	10	19.8	22.3
K	403	10	40.3	31.0
L	385	10	38.5	32.4
M	203	10	20.3	15.4
N	112	10	11.2	15.0
P	34	10	3.4	3.1
Q1	30	10	3.0	6.1
R		Dead (retired)		
S	25	3	8.3	3.8
T		Dead (retired)		
U	21	2	10.5	12.0
AA	699	10	69.9	43.0
CSA	964	9	107.1	79.5
CSB	723	10	72.3	67.4
CSC	2,193	9	243.7	164.9
CSD	16	10	1.6	2.7
CSE	274	5	54.8	56.7
CSF	345	10	34.5	24.8
CSG	826	10	82.6	35.9


Basin Creek Lake. Photo courtesy of Shannon Podruzny.


Lightning-struck whitebark pine. Photo courtesy of Jonathan Ball.

Habitat Monitoring

Grand Teton National Park Recreational Use *(Steve Cain, Grand Teton National Park)*

In 2009, total visitation in Grand Teton National Park was 3,845,838 people, including recreational, commercial (e.g. Jackson Hole Airport), and incidental (e.g. traveling through the Park on U.S. Highway 191 but not recreating) use. Recreational visits alone totaled 2,580,081. Backcountry user nights totaled 30,731. Long and short-term trends of recreational visitation and backcountry user nights are shown in Table 22 and Fig. 13.

Table 22. Average annual visitation and average annual backcountry use nights in Grand Teton National Park by decade from 1951 through 2009.

Decade	Average annual parkwide visitation[a]	Average annual backcountry use nights
1950s	1,104,357	Not available
1960s	2,326,584	Not available
1970s	3,357,718	25,267
1980s	2,659,852	23,420
1990s	2,662,940	20,663
2000s	2,497,847	30,049

[a] In 1983 a change in the method of calculation for parkwide visitation resulted in decreased numbers. Another change in 1992 increased numbers. Thus, parkwide visitation data for the 1980s and 1990s are not strictly comparable.

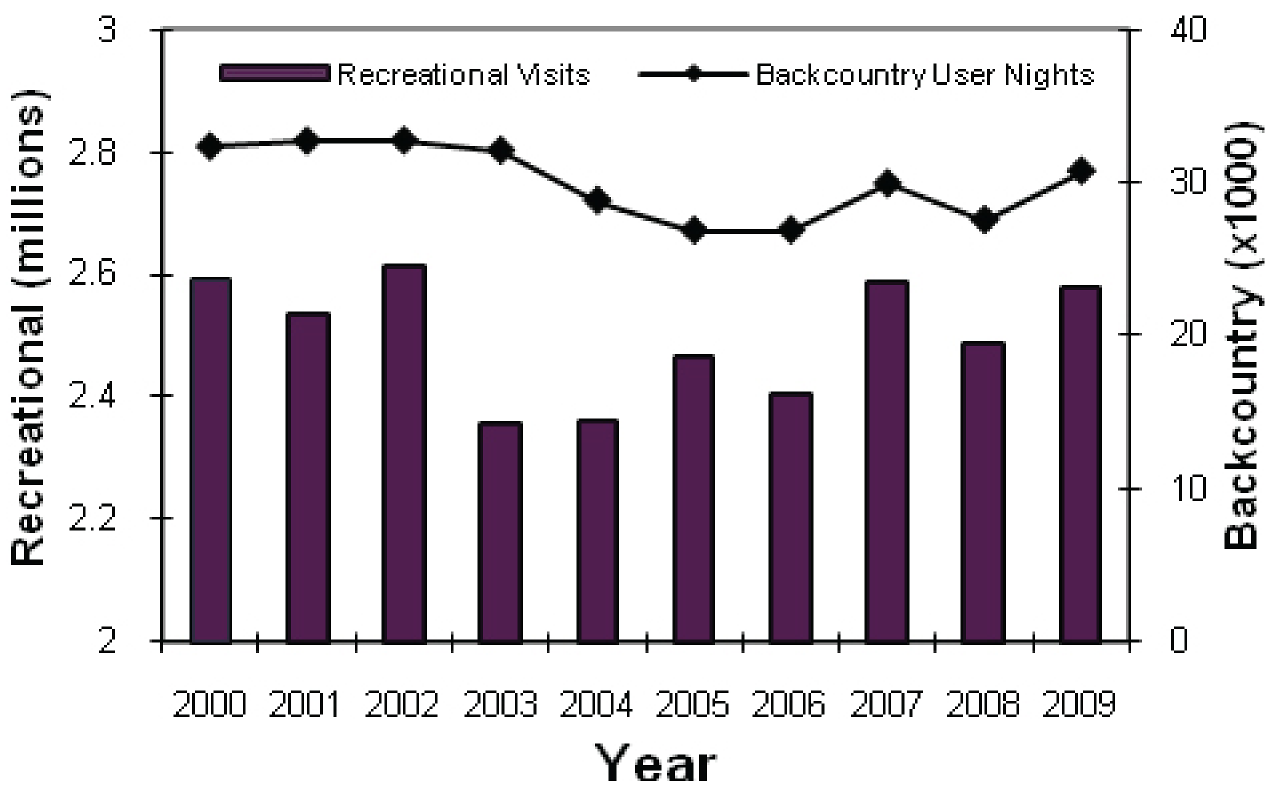


Fig. 13. Trends in recreational visitation and backcountry user nights in Grand Teton National Park during 2000–2009.

Yellowstone National Park Recreational Use *(Kerry A. Gunther, Yellowstone National Park)*

In 2009, total visitation to Yellowstone National Park was 4,152,923 people including recreational and non-recreational (e.g. traveling through the Park on U.S. Highway 191 but not recreating) use. Recreational visits alone totaled 3,295,186 a new record high for visitation in one year. These visitors spent 671,000 user nights camping in developed area roadside campgrounds and 39,714 user nights camping in backcountry campsites. The bulk of Yellowstone National Park's visitation occurs from May through September. In 2009 there were 3,048,543 recreational visitors during that time period, an average of 19,925 visitors per day.

Average annual recreational visitation increased each decade from an average of 7,378 visitors/year during the late 1890s to 3,012,653 visitors/year in the 1990s (Table 23). Average annual recreational visitation has decreased slightly since 2000, to an average of 2,967,718 visitors/year. The decade of 2000 through 2009 was the first in the history of the park that visitation did not increase from the previous decade. Average annual backcountry user nights have been less variable between decades than total park visitation, ranging from 39,280 to 45,615 user nights/year (Table 23). The number of backcountry user nights is limited by both the number and capacity of designated backcountry campsites in the park.

Table 23. Average annual visitation, auto campground user nights, and backcountry user nights in Yellowstone National Park by decade from 1895 through 2009.

Decade	Average annual parkwide total recreational visitation	Average annual auto campground user nights	Average annual backcountry user nights
1890s	7,378[a]	Not available	Not available
1900s	17,110	Not available	Not available
1910s	31,746	Not available	Not available
1920s	157,676	Not available	Not available
1930s	300,564	82,331[b]	Not available
1940s	552,227	139,659[c]	Not available
1950s	1,355,559	331,360	Not available
1960s	1,955,373	681,303[d]	Not available
1970s	2,240,698	686,594[e]	45,615[f]
1980s	2,344,485	656,093	39,280
1990s	3,012,653	647,083	43,605
2000s	2,967,718[g]	624,450[g]	40,362[g]

[a] Data from 1895-1899. From 1872–1894 visitation was estimated to be not less than 1,000 nor more than 5,000 each year.
[b] Data from 1930–1934.
[c] Average does not include data from 1940 and 1942.
[d] Data from 1960–1964.
[e] Data from 1975–1979.
[f] Backcountry use data available for the years 1972–1979.
[g] Data for the years 2000–2009.

Tourists and bears; JP Clum Lantern; 1910. NPS photo.

Trends in Elk Hunter Numbers within the Grizzly Bear Recovery Zone Plus the 10-mile Perimeter Area *(David S. Moody, Wyoming Game and Fish Department; Kevin Frey, Montana Department of Fish, Wildlife and Parks; and Daryl Meints, Idaho Department of Fish and Game)*

State wildlife agencies in Idaho, Montana, and Wyoming annually estimate the number of people hunting most major game species. We used state estimates for the number of elk hunters by hunt area as an index of hunter numbers for the RZ plus the 10-mile perimeter area. Because some hunt area boundaries do not conform exactly to the RZ and 10-mile perimeter area, regional biologists familiar with each hunt area were queried to estimate hunter numbers within the RZ plus the 10-mile perimeter area. Elk hunters were used because they represent the largest cohort of hunters for an individual species. While there are sheep, moose, and deer hunters using the RZ and 10-mile perimeter area, their numbers are fairly small and many hunt in conjunction with elk, especially in Wyoming, where seasons overlap. Elk hunter numbers represent a reasonably accurate index of total hunter numbers within areas occupied by grizzly bears in the GYE.

We generated a data set from all states from 1999 to 2009 (Table 24). Complete data does not exist for all years. Idaho and Montana do not calculate these numbers annually or, in some cases the estimates are not available in time for completing this report. As data become available it will be added in the future.

There has been a downward trend in hunter numbers in Idaho, Montana, and Wyoming since 1999 (Fig. 14). Until 2008, most of the decrease occurred in Wyoming and Montana. The majority of the decrease has occurred in Wyoming with over 7,000 fewer hunters. Montana has also experienced a significant decline in hunter numbers in the last 10 years, >3,700. Both Montana and Wyoming began to decrease the harvest of females in the early 2000s as elk herds approached their population objective. Idaho drastically reduced harvest objectives for females in 2008, which accounts for the decrease in hunter numbers in 2008 and presumably 2009.

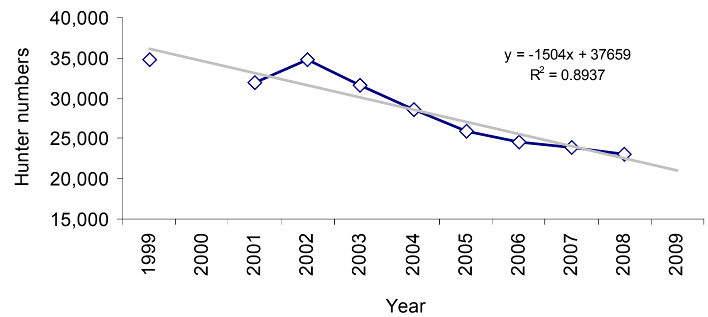


Fig. 14. Trend in elk hunter numbers within the Recovery Zone plus a 10-mile perimeter in Idaho, Montana, and Wyoming, 1999–2009.

Table 24. Estimated numbers of elk hunters within the Recovery Zone plus a 10-mile perimeter in Idaho, Montana, and Wyoming, for the years 1999–2009.

	Year										
State	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Idaho	2,883	[a]	2,914	3,262	3,285	3,454	3,619	3,016	2,592	1,763	[a]
Montana	16,254	17,329	15,407	17,908	16,489	14,320	12,365	12,211	12,635	12,470	[a]
Wyoming	15,727	12,812	13,591	13,709	11,771	10,828	9,888	9,346	8,716	8,792	8,440
Total	34,864		31,912	34,879	31,545	28,602	25,872	24,573	23,943	23,025	

[a] Hunter number estimates not currently available.

Grizzly Bear-Human Conflicts in the Greater Yellowstone Ecosystem *(Kerry A. Gunther, Yellowstone National Park; Bryan Aber, Idaho Department of Fish and Game; Mark T. Bruscino, Wyoming Game and Fish Department; Steve L. Cain, Grand Teton National Park; Kevin Frey, Montana Fish, Wildlife and Parks; and Mark A. Haroldson and Charles C. Schwartz, Interagency Grizzly Bear Study Team)*

Conservation of grizzly bears in the GYE requires providing sufficient habitat (Schwartz et al. 2003) and keeping human-caused bear mortality at sustainable levels (IGBST 2005, 2006). Most human-caused grizzly bear mortalities are directly related to grizzly bear-human conflicts (Gunther et al. 2004). Grizzly bear-human conflicts may also erode public support for grizzly bear conservation. To effectively allocate resources for implementing management actions designed to prevent grizzly bear-human conflicts from occurring, land and wildlife managers need baseline information for the types, causes, locations, and trends of conflict incidents. To address this need, we record all grizzly bear-human conflicts reported in the GYE annually. We group conflicts into 6 broad categories using standard definitions described by Gunther et al. (2000, 2001). To identify trends in areas with concentrations of conflicts, we calculated the 80% isopleth for the distribution of conflicts from the most recent 3-year period (2007–2009), using the fixed kernel estimator in the Animal Movements (Hooge and Eichenlaub 1997) extension for ArcView GIS (Environmental Systems Research Institute 2002).

The frequency of grizzly bear-human conflicts is inversely associated with the abundance of natural bear foods (Gunther et al. 2004). When native bear foods are of average or above average abundance there tend to be few grizzly bear-human conflicts involving property damage and anthropogenic foods. When the abundance of native bear foods is below average, incidents of grizzly bears damaging property and obtaining human foods and garbage increase, especially during late summer and fall when bears are hyperphagic (Gunther et al. 2004). Livestock depredations tend to occur independently of the availability of natural bear foods (Gunther et al. 2004). In 2009, the availability of high-quality, concentrated bear foods was above average during the spring season, average during estrus and early hyperphagia, and above average during late hyperphagia. During spring, the number winter-killed ungulate carcasses on the Northern Ungulate Winter Range were approximately equal to the long-term average (see *Spring Ungulate Availability)*. During estrus, very few spawning cutthroat trout were observed in monitored tributary streams of Yellowstone Lake (see *Spawning Cutthroat Trout*). However, predation on newborn elk calves was frequently observed during the estrus season. During early-hyperphagia many grizzly bears were observed at high elevation army cutworm moth aggregation sites (see *Grizzly Bear Use of Insect Aggregation Sites*), and abundant berry crops attracted bears in Grand Teton National Park. During late hyperphagia, whitebark pine seed production was considered good to excellent throughout most of the ecosystem (see *Whitebark Pine Cone Production*).

There were 148 grizzly bear-human conflicts reported in the GYE in 2009 (Table 25, Fig. 15). These incidents included bears killing livestock (49%, *n* = 72), damaging property while obtaining anthropogenic foods (27%, *n* = 40), damaging property without obtaining anthropogenic foods (11%, *n* = 16), obtaining vegetables and fruit from gardens and orchards (10%, *n* = 14), and injuring people (4%, *n* = 6). Conflicts were relatively evenly distributed between public and private lands. Fifty-one percent (*n* = 75) of the conflicts occurred on public land administered by the U.S. Forest Service (49%, *n* = 73), Bureau of Land Management (1%, *n* = 1), and National Park Service (1%, *n* = 1). Forty-nine percent (*n* = 73) of the conflicts occurred on private land in the states of Wyoming (33%, *n* = 49) and Montana (16%, *n* = 24). There were no conflicts reported on private land in Idaho. Most (72%, *n* = 107) of the bear-human conflicts in 2009 occurred outside of the Grizzly Bear Recovery Zone. Only 28% (*n* = 41) of the bear-human conflicts occurred within the Recovery Zone. The number of incidents of grizzly bears damaging property, obtaining anthropogenic foods, damaging beehives, and injuring people in 2009, were similar to the long-term averages recorded from 1992–2008 (Table 26). Livestock depredations and incidents of bears eating apples and damaging apple trees were slightly higher than the long-term average. Apple trees at private residences throughout the GYE produced abundant apple crops in 2009.

The conflict distribution map constructed using the fixed kernel 80% conflict distribution isopleths, identified 5 areas where most grizzly bear-human conflicts in the GYE occurred over the last 3 years

(Fig. 16). These 5 areas contained 411 (76%) of the 539 conflicts that occurred from 2007–2009. The 5 areas where most conflicts occurred over the last 3 years included: 1) the area encompassing Cooke City, Montana, the Clarks Fork River, Crandall Creek, Sunlight Creek, and the North and South Forks of the Shoshone River (152 conflicts); 2) the Green River and Dunoir Creek drainages (134 conflicts); 3) the Gardiner Basin (64 conflicts), 4) the area encompassing West Yellowstone, Montana, and Island Park, Idaho (47 conflicts); and 5) the area encompassing the Wood River, Cottonwood Creek, and Grass Creek drainages (14 conflicts). These 5 areas should receive consideration when allocating state, federal, and private resources available for reducing grizzly bear-human conflicts in the GYE.

Grizzly bear habitat under different types of ownership and land management mandates each had predominately different types of bear-human conflicts in 2009. On private land, incidents of bears damaging property and obtaining anthropogenic foods (garbage, grain, bird seed, dog food, garden vegetables, apples) were the most common type (69%, 50 of 73) of grizzly bear-human conflict reported. On lands managed by the U.S. Forest Service, cattle and sheep depredations were the most common (77%, 56 of 73) type of conflict. There was only 1 conflict on lands under Bureau of Land Management jurisdiction, a bear-inflicted human injury. On lands under National Park Service jurisdiction, there was also only 1 conflict of any type, a property damage, but habituation of bears to people was a significant

Table 25. Number of incidents of grizzly bear-human conflicts reported within different land ownership areas in the Greater Yellowstone Ecosystem, 2009.

Land owner[a]	Property damages	Anthropogenic foods	Human injury	Gardens/ Orchards	Beehives	Livestock depredations	Total Conflicts
ID-private	0	0	0	0	0	0	0
ID-state	0	0	0	0	0	0	0
MT-private	2	19	0	2	0	1	24
MT-state	0	0	0	0	0	0	0
WY-private	5	17	0	12	0	15	49
WY-state	0	0	0	0	0	0	0
BLM	0	0	1	0	0	0	1
BDNF	0	0	0	0	0	0	0
BTNF	1	3	1	0	0	37	42
CNF	0	0	0	0	0	0	0
CTNF	0	0	1	0	0	5	6
GNF	1	1	3	0	0	0	5
SNF	6	0	0	0	0	14	20
GTNP/JDR	0	0	0	0	0	0	0
YNP	1	0	0	0	0	0	1
Total	16	40	6	14	0	72	148

[a] BLM = Bureau of Land Management, BDNF = Beaverhead-Deerlodge National Forest, BTNF = Bridger-Teton National Forest, CNF = Custer National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP/JDR = Grand Teton National Park/John D. Rockefeller, Jr. Memorial Parkway, ID = Idaho, MT = Montana, SNF = Shoshone National Forest, WY = Wyoming, YNP = Yellowstone National Park..

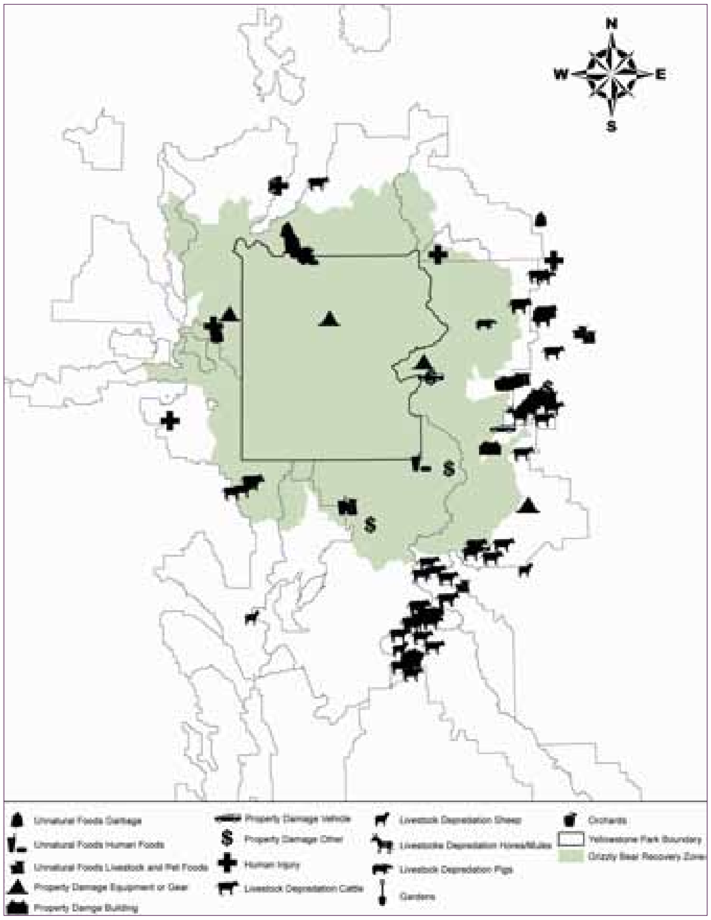


Fig. 15. Locations of different types of grizzly bear-human conflicts reported in the Greater Yellowstone Ecosystem in 2009. The shaded area represents the Yellowstone Grizzly Bear Recovery Zone.

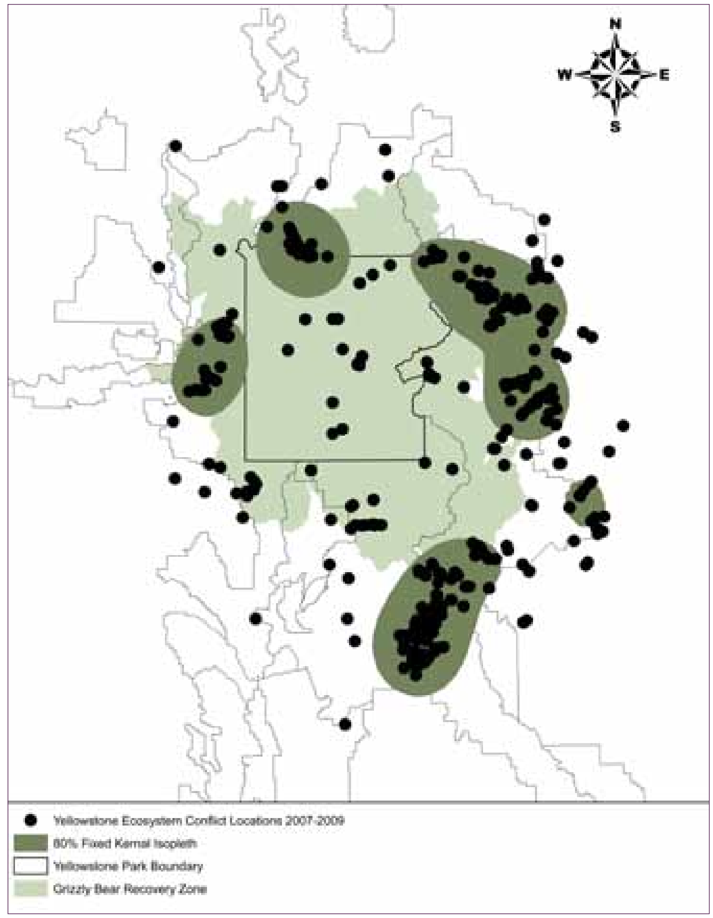


Fig. 16. Concentrations (dark shaded polygons) of grizzly bear-human conflicts that occurred from 2007–2009, identified using the 80% fixed kernel isopleth. The lightly shaded background area represents the Yellowstone Grizzly Bear Recovery Zone.

Table 26. Comparison between the number of incidents of different types of grizzly bear-human conflicts in 2009 and the average annual number of conflicts recorded from 1992–2008 in the Greater Yellowstone Ecosystem.

Type of conflict	1992–2008 Average ± SD	2009
Human injury	5 ± 3	6
Property damage	21 ± 12	16
Anthropogenic foods	57 ± 38	40
Gardens/orchards	6 ± 5	14
Beehives	3 ± 4	0
Livestock depredations	52 ± 18	72
Total conflicts	142 ± 55	148

management challenge. In Grand Teton National Park (GTNP), the number of incidents where habituated grizzly bears frequented roadside meadows and the outskirts of developments continued to increase in 2009. GTNP staff managed visitors and bears at 129 roadside grizzly bear-jams. In Yellowstone National Park (YNP), the number of bear-jams was among the highest recorded since prohibitions against hand feeding of bears were enforced in 1970. There were 314 grizzly bear-jams reported in YNP in 2009. In both parks, a significant amount of staff time was spent managing habituated bears and the visitors that want to view and photograph habituated bears that feed on native foods in roadside meadows. No conflicts involving roadside habituated bears occurred in either park.

Literature Cited

Andrascik, R. 1992. Lake area-Bridge Bay spawning survey. Pages 29–35 *in* R. Andrascik, D.G. Carty, R.D. Jones, L.R. Kaeding, B.M. Kelly, D.L. Mahony, and S.T. Olliff. Annual project report for 1991, Fishery and Aquatic Management Program, Yellowstone National Park. U.S. Fish and Wildlife Service, Fisheries Assistance Office, Yellowstone National Park, Wyoming, USA.

Basile, J. 1982. Grizzly bear distribution in the Yellowstone area, 1973–79. Research Note INT-321. U.S. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah, USA.

Blanchard, B. 1985. Field techniques used in the study of grizzly bears. Interagency Grizzly Bear Study Team report. National Park Service, Bozeman, Montana, USA.

Blanchard, B.M. 1987. Size and growth patterns of the Yellowstone grizzly bear. International Conference on Bear Research and Management 7:99–107.

Blanchard, B.M. 1990. Relationship between whitebark pine cone production and fall grizzly bear movements. Pages 362–363 *in* W.C. Schmidt and K.J. McDonald, compilers. Proceedings of symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource. U.S. Forest Service General Technical Report INT-270. U.S. Department of Agriculture, Forest Service, Ogden, Utah, USA.

Blanchard, B., and R. Knight. 1991. Movements of Yellowstone grizzly bears, 1975–87. Biological Conservation 58:41–67.

Blanchard, B.M., and R.R. Knight. 1996. Effects of wildfire on grizzly bear movements and foraging strategies. Pages 117–122 *in* J.M. Greenlee, editor. Proceedings of the second biennial scientific conference on the Greater Yellowstone Ecosystem. International Association of Wildland Fire, Fairfield, Washington, USA.

Blanchard, B.M., R.R. Knight, and D.J. Mattson. 1992. Distribution of Yellowstone grizzly bears during the 1980s. American Midland Naturalist 128:332–338.

Burnham, K.P., and D.R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Second edition. Springer-Verlag, New York, New York, USA.

Chao, A. 1989. Estimating population size for sparse data in capture-recapture experiments. Biometrics 45:427–438.

Cherry, S., M.A. Haroldson, J. Robison-Cox, and C.C. Schwartz. 2002. Estimating total human-caused mortality from reported mortality using data from radio-instrumented grizzly bears. Ursus 13:175–184.

Cherry, S., G.C. White, K.A. Keating, M.A. Haroldson, and C.C. Schwartz. 2007. Evaluating estimators for numbers of females with cubs-of-the-year in the Yellowstone grizzly bear population. Journal of Agricultural, Biological, and Environmental Statistics 12(2):195–215.

Cole, G.F. 1971. An ecological rationale for the natural or artificial regulation of native ungulates in parks. Transactions of the North American Wildlife and Natural Resources Conference 36:417–425.

Craighead, J.J., K.R. Greer, R.R. Knight, and H.I. Pac. 1988. Grizzly bear mortalities in the Yellowstone Ecosystem, 1959–1987. Report of the Montana Department of Fish, Wildlife and Parks; Craighead Wildlife Institute; Interagency Grizzly Bear Study Team; and National Fish and Wildlife Foundation.

Craighead, J.J., J. Sumner, and J.A. Mitchell. 1995. The grizzly bears of Yellowstone: their ecology in the Yellowstone ecosystem, 1959–1992. Island Press, Washington, D.C., USA.

Eberhardt, L.L. 1995. Population trend estimates from reproductive and survival data. Pages 13–19 *in* R.R. Knight and B.M. Blanchard, authors. Yellowstone grizzly bear investigations: report of the Interagency Study Team, 1994. National Biological Service, Bozeman, Montana, USA.

Eberhardt, L.L., B.M. Blanchard, and R.R. Knight. 1994. Population trend of Yellowstone grizzly bear as estimated from reproductive and survival rates. Canadian Journal of Zoology 72:360–363.

Environmental Systems Research Insitute. 2002. ArcView GIS. Version 3.3. Environmental Systems Research Institute, Inc., Redlands, California, USA.

Farnes, P.E. 1991. A scaled index of winter severity. 59th Proceedings of the Western Snow Conference, 12–15 April 1991, Juneau, Alaska, USA.

French, S.P., M.G. French, and R.R. Knight. 1994. Grizzly bear use of army cutworm moths in the Yellowstone ecosystem. International Conference on Bear Research and Management 9:389–399.

Green, G.I. 1994. Use of spring carrion by bears in Yellowstone National Park. Thesis, University of Idaho, Moscow, Idaho, USA.

Gunther, K.A., M.T. Bruscino, S. Cain, J. Copeland, K. Frey, M.A. Haroldson, and C.C. Schwartz. 2000. Grizzly bear-human conflicts confrontations, and management actions in the Yellowstone ecosystem, 1999. Pages 55–108 *in* C.C. Schwartz and M.A. Haroldson, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1999. U.S. Geological Survey, Bozeman, Montana, USA.

Gunther, K.A., M.T. Bruscino, S. Cain, J. Copeland, K. Frey, M.A. Haroldson, and C.C. Schwartz. 2001. Grizzly bear-human conflicts confrontations, and management actions in the Yellowstone ecosystem, 2000. Pages 64–109 *in* C.C. Schwartz and M.A. Haroldson, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2000. U.S. Geological Survey, Bozeman, Montana, USA.

Gunther, K.A., M.A. Haroldson, K. Frey, S.L. Cain, J. Copeland, and C.C. Schwartz. 2004. Grizzly bear-human conflicts in the Greater Yellowstone Ecosystem, 1992-2000. Ursus 15(1):10–24.

Haroldson, M.A. 2009. Assessing trend and estimating population size from counts of unduplicated females. Pages 9–14 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2008. U.S. Geological Survey, Bozeman, Montana, USA.

Haroldson, M.A., K.A. Gunther, D.P. Reinhart, S.R. Podruzny, C. Cegelski, L. Waits, T. Wyman, and J. Smith. 2005. Changing numbers of spawning cutthroat trout in tributary streams of Yellowstone Lake and estimates of grizzly bears visiting streams from DNA. Ursus 16(2):167–180.

Haroldson, M.A., K.A. Gunther, and T. Wyman. 2008. Possible grizzly cub adoption in Yellowstone National Park. Yellowstone Science 16(2):42-44.

Haroldson, M.A., M. Ternent, G. Holm, R.A. Swalley, S. Podruzny, D. Moody, and C.C. Schwartz. 1998. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1997. U.S. Geological Survey, Biological Resources Division, Bozeman, Montana, USA.

Harris, R.B., G.C. White, C.C. Schwartz, and M.A. Haroldson. 2007. Population growth of Yellowstone grizzlies: uncertainty, correlation, and future monitoring. Ursus 18(2):167–177.

Henry, J., and D.J. Mattson. 1988. Spring grizzly bear use of ungulate carcasses in the Firehole River drainage: third year progress report. Pages 51–59 *in* R.R. Knight, B.M. Blanchard, and D.J. Mattson, authors. Yellowstone grizzly bear investigations: annual report of the Interagency Study Team, 1987. National Park Service, Bozeman, Montana, USA.

Hooge, P.N., and B. Eichenlaub. 1997. Animal movement extension to ArcView. Version 1.1. Alaska Biological Science Center, U.S. Geological Survey, Anchorage, Alaska, USA.

Hoskins, W.P. 1975. Yellowstone Lake tributary study. Interagency Grizzly Bear Study Team unpublished report, Bozeman, Montana, USA.

Houston, D.B. 1982. The northern Yellowstone elk. Macmillan Publishing Company, New York, New York, USA.

Interagency Grizzly Bear Study Team. 2005. Reassessing methods to estimate population size and sustainable mortality limits for the Yellowstone grizzly bear. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

Interagency Grizzly Bear Study Team. 2006. Reassessing methods to estimate population size and sustainable mortality limits for the Yellowstone grizzly bear: workshop document supplement. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

Interagency Grizzly Bear Study Team. 2008. Reassessing methods to distinguish unique female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Montana State University, Bozeman, Montana, USA.

Keating, K.A., C.C. Schwartz, M.A. Haroldson, and D. Moody. 2002. Estimating numbers of females with cubs-of-the-year in the Yellowstone grizzly bear population. Ursus 13:161–174.

Knight, R.R., B.M. Blanchard, and L.L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the-year. Wildlife Society Bulletin 23:245–248.

Knight, R.R., and L.L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. Ecology 66:323–334.

Knight, R.R., D.J. Mattson, and B.M. Blanchard. 1984. Movements and habitat use of the Yellowstone grizzly bear. Interagency Grizzly Bear Study Team report. National Park Service, Bozeman, Montana, USA.

Koel, T.M., J.L. Arnold, P.E. Bigelow, P.D. Doepke, B.D. Ertel, and D.L. Mahony. 2005*b*. Yellowstone Fisheries & Aquatic Sciences: annual report, 2004. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, USA.

Koel, T.M., J.L. Arnold, P.E. Bigelow, P.D. Doepke, B.D. Ertel, and M.E. Ruhl. In press. Yellowstone Fisheries & Aquatic Sciences: annual report, 2009. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, USA. YCR-NR-2009.

Koel, T.M., P.E. Bigelow, P.D. Doepke, B.D. Ertel, and D.L. Mahony. 2005*a*. Nonnative lake trout result in Yellowstone cutthroat trout decline and impacts to bears and anglers. Fisheries 30(11):10–19.

Koel, T.M., D.L. Mahony, K.K. Kinnan, C. Rasmussen, C.J. Hudson, S. Murcia, and B.L. Kerans. 2006. *Myxobolus cerebralis* in native cutthroat trout of the Yellowstone Lake ecosystem. Journal of Aquatic Animal Health 18:157–175.

Mattson, D.J. 1997. Use of ungulates by Yellowstone grizzly bears *Ursus arctos*. Biological Conservation 81:161–177.

Mattson, D.J., B.M. Blanchard, and R.R. Knight. 1991*a*. Food habits of Yellowstone grizzly bears. Canadian Journal of Zoology 69:1619–1629.

Mattson, D.J., B.M. Blanchard, and R.R. Knight. 1992. Yellowstone grizzly bear mortality, human-habituation, and whitebark pine seed crops. Journal of Wildlife Management 56:432–442.

Mattson, D.J., C.M. Gillin, S.A. Benson, and R.R. Knight. 1991*b*. Bear feeding activity at alpine insect aggregation sites in the Yellowstone ecosystem. Canadian Journal of Zoology 69:2430–2435.

Mattson, D.J., and D.P. Reinhart. 1995. Influences of cutthroat trout (*Oncorhynchus clarki*) on behavior and reproduction of Yellowstone grizzly bears (*Ursus arctos*), 1975-1989. Canadian Journal of Zoology 73:2072–2079.

Mealey, S.P. 1975. The natural food habits of free ranging grizzly bears in Yellowstone National Park, 1973–1974. Thesis, Montana State University, Bozeman, Montana, USA.

Mealey, S.P. 1980. The natural food habits of grizzly bears in Yellowstone National Park, 1973–74. International Conference on Bear Research and Management 4:281–292.

Olliff, S.T. 1992. Grant Village spawning stream survey. Pages 36–43 *in* R. Andrascik, D.G. Carty, R.D. Jones, L.R. Kaeding, B.M. Kelly, D.L. Mahony, and S.T. Olliff. Annual project report for 1991, Fishery and Aquatic Management Program, Yellowstone National Park. U.S. Fish and Wildlife Service, Fisheries Assistance Office, Yellowstone National Park, Wyoming, USA.

Reinhart, D.P. 1990. Grizzly bear habitat use on cutthroat trout spawning streams in tributaries of Yellowstone Lake. Thesis, Montana State University, Bozeman, Montana, USA.

Reinhart, D.P., and D.J. Mattson. 1990. Bear use of cutthroat trout spawning streams in Yellowstone National Park. International Conference on Bear Research and Management 8:343–350.

Schwartz, C.C., M.A. Haroldson, and S. Cherry. 2006*a*. Reproductive performance of grizzly bears in the Greater Yellowstone Ecosystem, 1983–2002. Pages 17–24 *in* C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cherry, K.A. Keating, D. Moody, and C. Servheen, authors. 2006. Temporal, spatial and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161:1–68.

Schwartz, C.C., M.A. Haroldson, S. Cherry, and K.A. Keating. 2008. Evaluation of rules to distinguish unique female grizzly bears with cubs in Yellowstone. Journal of Wildlife Management 72(2):543–554.

Schwartz, C.C., M.A. Haroldson, and G.C. White. 2006*b*. Survival of cub and yearling grizzly bears in the Greater Yellowstone Ecosystem, 1983–2001. Pages 25–31 *in* C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cherry, K.A. Keating, D. Moody, and C. Servheen, authors. 2006. Temporal, spatial and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161:1–68.

Schwartz, C.C., S.D. Miller, and M.A. Haroldson. 2003. Grizzly bear. Pages 556–586 *in* G.A. Feldhammer, B.C. Thompson, and J.A. Chapman, editors. Wild Mammals of North America: biology, management, and conservation. Second edition. The John Hopkins University Press, Baltimore, Maryland, USA.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. Macmillian Publishing Company, Incorporated, New York, New York, USA.

Swenson, J.E., and M.A. Haroldson. 2008. Observations of mixed-aged litters in brown bears. Ursus 19(1):73-79.

Ternent, M., and M. Haroldson. 2000. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 36–39 *in* C.C. Schwartz and M.A. Haroldson, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1999. U.S. Geological Survey, Bozeman, Montana, USA.

U.S. Fish and Wildlife Service. 1993. Grizzly bear recovery plan. Missoula, Montana, USA.

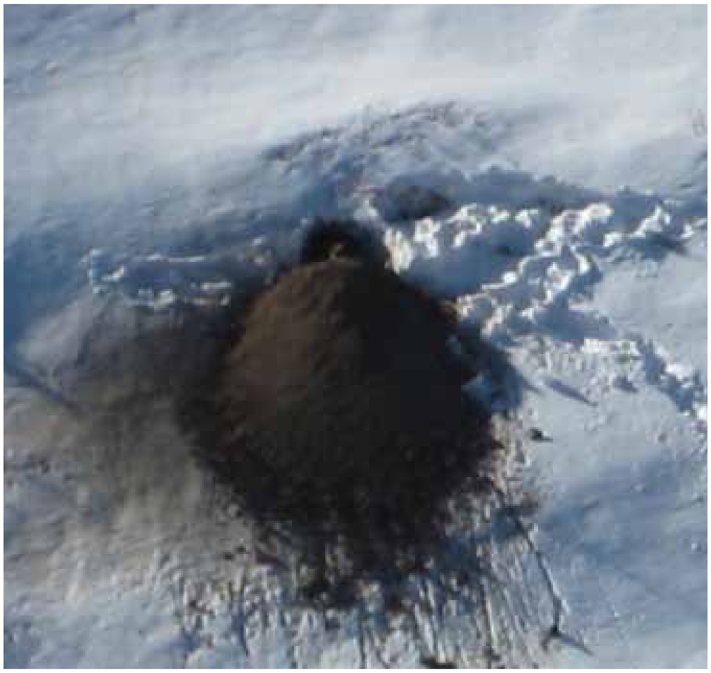
U.S. Fish and Wildlife Service. 2003. Final Conservation Strategy for the grizzly bear in the Yellowstone Ecosystem. U.S. Fish and Wildlife Service, Missoula, Montana, USA.

U.S. Fish and Wildlife Service. 2007*a*. Final Rule designating the Greater Yellowstone Area population of grizzly bears as a Distinct Population Segment and removing the Yellowstone Distinct Population Segment of grizzly bears from the Federal List of Endangered and Threatened Wildlife. 72 FR 14866. Available at http://www.fws.gov/mountain-prairie/species/mammals/grizzly/FR_Final_YGB_rule_03292007.pdf.

U.S. Fish and Wildlife Service. 2007*b*. Grizzly Bear Recovery Plan Supplement: revised demographic criteria for the Yellowstone Ecosystem. 72 FR 11377. Available at http://www.fws.gov/mountain-prairie/species/mammals/grizzly/Grizzly_bear_Recovery_Plan_supplement_demographic.pdf.

U.S. Fish and Wildlife Service. 2007*c*. Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area. Available at http://www.fws.gov/mountain-prairie/species/mammals/grizzly/Final_Conservation_Strategy.pdf.

Wilson, R.M., and M.F. Collins. 1992. Capture-recapture estimation with samples of size one using frequency data. Biometrika 79:543–553.



Grizzly bear at den entrance, Nov 2009. This bear emerged from the den in Apr 2010 with 1 cub-of-the-year. Photo courtesy of Brian DeBolt/Wyoming Game and Fish.

2009 Annual Progress Report

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Title: Assessing habitat and diet selection for grizzly (*Ursus arctos*) and American black bears (*Ursus americanus*) in Yellowstone National Park

Introduction: A broad study of grizzly and black bears using the area around Yellowstone Lake was initiated in the fall of 2006. The purpose of this 3-year study is to determine if spawning cutthroat trout (*Oncorhynchus clarkii*) continue to be an important food for bears, or if the trout population has declined to the level that bears no longer use this resource. If trout are no longer a useful food resource, we want to determine what geographical areas and foods the bears are using and if those foods are an adequate replacement to maintain a healthy population of grizzly bears.

Capture and collaring: Bears were trapped around Yellowstone Lake during the fall of 2006, early summer and fall of both 2007 and 2008, and early summer of 2009. Twenty-one grizzly bears (8 females and 13 males) and 6 male black bears have been captured and fitted with Spread Spectrum Technology (SST) Global Positioning System (GPS) collars.

Telemetry results: Thirteen grizzly bears (5 female and 8 male) and 4 male black bears were radio tracked during this year's field season (11 May–9 Oct). Approximately 47,173 GPS locations were recorded by these collars during the 2009 field season. Six collars were dropped prematurely: 22512 on 8/29, 567 on 5/12, 204 on 9/23, 589 between 8/17 and 8/24, 363 on 8/16, and 448 on 6/16. The GPS portion of 589's collar failed on 8/9 prior to being dropped. Female grizzly bear 448 was recollared on 7/9 and the collar is scheduled to remain on until 6/15/10 to see if she produces cubs. Ten (492, 541, 22513, 22515, 201, 568, 338, 481, 616, and 22511) of the remaining 11 collars were dropped on schedule. All collars except 568 were retrieved, it will be retrieved during the spring 2010 when snow conditions allow for access. Bear 515 retained his collar through denning and continues to wear it at the time of this writing. None of these collared grizzly bears had cubs during the 2009 field season.

Site visits: Four 2-person crews (2 graduate students along with 6 volunteers) were employed for the 2009 field season. The field crews visited GPS locations to record bear activity, including habitat and dietary item use. We visited 1,258 GPS locations at which we collected 126 hair samples, 475 fecal samples, and forage samples. Of these sites, 429 were Level 1 only in their analysis, 829 continued to Level 2 analysis, and 253 to Level 3 analysis. All data was entered into an Access database.

Level 2 site visits that included feeding consisted of carcasses, insects, roots, false-truffles, and whitebark pine (*Pinus albicaulis*) nuts. Carcasses consisted of 19 elk (*Cervus elaphus*), 1 bison (*Bison bison*), and 1 mule deer (*Odocoileus hemionus*). Insect sites consisted of 36 ant hills or log tears and 14 other insect and/or earthworms sites. Roots were mainly yampa (*Perideridia gairdneri*) at 39 sites with 21 biscuitroot (*Lomatium* spp.), 5 licorice root (*Osmorhiza spp.*), 3 onion grass (*Melica* spp.), and 2 glacier lily (*Erythronium grandiflorum*) also used. There were 111 whitebark pine nut middens, 15 rodent caches, 12 fungi sites (*Rhizopogon* spp.), and 7 cambium scrapes. It was a good whitebark pine cone year with counts in YNP averaging 46.5 cones/tree.

Level 3 foraging or grazing sites were highly composed of all three categories: graminoids, forbs, and berries. Graminoid site visits included: 10 bluegrass (*Poa* spp.), 7 sedge (*Carex* spp.), 2 wheatgrass (*Agropyron* spp.), and 1 timothy (*Phleum* spp.). The dominant forbs at site visits were dandelion (*Taraxacum* spp.) at 57, 31 clover (*Trifolium* spp.), and 27 fireweed (*Epilobium* spp.). Other forbs used were: 17 elk thistle (*Cirsium scariosum*), 15 fern-leaved lovage (*Ligusticum filicinum*), 12 sticky geranium (*Geranium viscosissimum*), 7 cow parsnip (*Heracleum maximum*), 5 of both *Aster* spp. and lousewort (*Pedicularis* spp.), 4 of both mountain bluebells (*Mertensia ciliata*) and paintbrush (*Castilleja* spp.), 3 of both buckwheat (*Eriogonum* spp.) and bistort root (*Polygonum* spp.), and 1 each of *Agoseris* spp., wild chives (*Allium* spp.), angelica (*Angelica* spp.), and horsetail (*Equisetum arvense*). Berry production was decent in 2009 with use composed of: 23 grouse whortleberry (*Vaccinium scoparium*), 6 each of elderberry (*Sambucus racemosa*) and globe huckleberry (*Vaccinium globulare*), 5 raspberry (*Rubus* spp.), 4 gooseberry (*Ribes* spp.), and 1 each of buffaloberry (*Sheperdia canadensis*) and strawberry (*Fragaria* spp.).

Hair snares: Forty-eight hair snares were deployed on 35 streams on Yellowstone Lake. Hair snares were visited bi-weekly from mid-May through mid-August during which time 355 hair samples were collected. Stream surveys for spawning cutthroat trout were conducted in conjunction with hair snare visits. Of the 35 streams surveyed, 21 contained spawning cutthroat and 19 contained fry and/or fingerlings during at least one stream survey. Maximum number of cutthroat trout spawners seen during one stream survey was 25. Fry and/or fingerling counts were often estimated to be several hundred. All data was entered into an Access database.

Hair Snare Results: As part of a project to understand current use of cutthroat trout by both black and grizzly bears, we collected 355 hair samples at hair snag corrals (n = 48) placed along tributary streams of Yellowstone Lake during the historic spawning period of 2009. We sent 195 of these samples to Wildlife Genetics International for genetic analyses; the lab identified 30 grizzly bears (17 male, 13 female) and 12 black bears (6 male, 6 female).

Over the course of the project (2007–2009), we collected 1,535 hair samples under the same design. We sent 877 of these samples off for genetic analysis. Seven hundred forty-six (85%) samples were assigned to individual bears using a suite of 7 microsatellite loci (observed heterozygosity across 7 loci: 0.672 for grizzlies and 0.650 for black bears). From this assignment, we now know at least 63 grizzly bears (42 male, 21 female) and 27 black bears (17 male, 10 female) visited tributary stream courses during this time. Of these, 8 male and 7 female black bears (15 in total; 56% of total number identified) and 12 male and 8 female grizzly bears (20 in total; 32% of total number identified) visited streams located near human development (front-country). Only 9 (18%) grizzly bears visited these areas during a period between 1997 and 2000 (Haroldson et al. 2005).

Literature Cited

Haroldson, M.A., K.A. Gunther, D.P. Reinhart, S.R. Podruzny, C. Cegelski, L. Waits, T. Wyman, and J. Smith. 2005. Changing numbers of spawning cutthroat trout in tributary streams of Yellowstone Lake and estimates of grizzly bears visiting streams from DNA. Ursus 16(2):167–180.

Adult male black bear captured visiting a hair snare corral with a remote digital camera. Corrals were placed along tributary streams to Yellowstone Lake that had an historical cutthroat trout spawning run.

2009 Wyoming Bear Wise Community Project Update

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Introduction

The Bear Wise Community program is a proactive initiative that seeks to minimize human-bear conflicts, minimize management-related bear mortalities associated with preventable conflicts, and to safeguard human communities in northwest Wyoming. The overall objective of the program is to promote individual and community ownership of the ever-increasing human-bear conflict issue and eventually, create a social conscience regarding responsible attractant management. What's more, this project will raise awareness and proactively influence local waste management infrastructures with the specific intent of preventing conflicts from recurring. Strategies used to meet the campaign's objectives are: 1) minimize accessibility of unnatural attractants to bears in developed areas; 2) employ a public outreach and education campaign to reduce knowledge gaps about bears and the causes of conflicts; and 3) employ a bear-resistant waste management system and promote bear-resistant waste management infrastructure.

This report provides a summary of program accomplishments in 2009. Progress and past accomplishments are reported in the 2008 annual report of the Interagency Grizzly Bear Study Team (IGBST) (Hodges and Boyce 2009).

Background

In 2004, a subcommittee of the IGBST conducted an analysis of the causes and spatial distribution of grizzly bear (*Ursus arctos*) mortalities and conflicts in the Greater Yellowstone Area (GYA) during the period of 1994–2003. The analysis identified that the majority of known, human-caused bear mortalities occurred due to agency management actions in response to conflicts (34%), self defense killings, primarily by ungulate hunters (20%), and vandal killings (11%). The report made 33 recommendations to reduce human-grizzly bear conflicts and mortalities with focus on three actions that could be positively influenced by agency resources and personnel: 1) reduce conflicts at developed sites; 2) reduce self-defense killings; and 3) reduce vandal killings (Servheen et al. 2004).

To address action number one, the committee recommended that a demonstration area be established to focus proactive, innovative, and enhanced management strategies where developed site conflicts and agency management actions resulting in relocation or removal of bears had historically been high. Spatial examination of conflicts identified the Wapiti area in northwest Wyoming as having one of the highest concentrations of black bear (*Ursus americanus*) and grizzly bear conflicts in the GYA. The North Fork of the Shoshone River drainage west of Cody was then chosen as the first area composed primarily of private land to have a multi-agency/public approach to reducing conflicts at developed sites.

In 2005, the Wyoming Game & Fish Department (WGFD) began implementation of the Bear Wise Community program as part of this initiative. Although the program's efforts were focused primarily in the Wapiti area, the WGFD also initiated a smaller scale project in Teton County to address the increasing number of black and grizzly bear conflicts in the Jackson area. For the last four years, the Bear Wise Community programs in both Cody and Jackson have deployed a multi-facetted education and outreach campaign in an effort to minimize human-bear conflicts and promote proper attractant management. Although a wide array of challenges remain and vary between communities, many accomplishments have been made and significant progress is expected to continue as Bear Wise efforts gain momentum.

Wapiti Bear Wise Community Project Update

The Wapiti Bear Wise Community program is at the end of the fourth year since implementation. Thus far, the program has utilized radio, television and print media, public workshops and programs, contact with youth organizations such as the Boy Scouts, 4H, and public schools, mass mailings, and the use of signing on private and public land to convey the educational messages surrounding human-bear conflict prevention. To compliment educational initiatives, the program uses an extensive outreach campaign that assists the community in obtaining and utilizing bear-resistant products and alternative methods of attractant management. Efforts and accomplishments for 2009 are as follows:

Ongoing Efforts:

1. In 2007 and 2008, 140 95-gallon bear-resistant garbage carts were purchased with grant funding. The carts are offered to community members for the reduced price of $49.99. To date, 75 carts have been sold and are in use in Park County. Because of increased consumer demand and cooperation from local sanitation companies, the remaining cart inventory will be transferred to local sanitation providers in the Cody area in 2010.

2. Partnership with the North Fork Bear Wise Group continues. The group, comprised of six local Wapiti citizens, meets monthly to articulate community needs and assist in the development of educational and outreach initiatives.

3. A "Bear Aware" billboard, "Bear Use Area" highway signs, and educational kiosks remain posted throughout Wapiti and the Crandall/Sunlight area north of Cody. Kiosk message boards are updated three times during the non-denning season with seasonally appropriate conflict prevention information.

4. Public libraries across northwest Wyoming continue to offer *Staying Safe in Bear Country* and *Living in Bear Country* DVD's and the *Living in Bear Country* book by Linda Masterson that the Bear Wise Community program purchased and donated in 2006.

5. Bear Aware tips continue to be included in the local Wapiti School calendar. Tips contain seasonally appropriate messages regarding bear behavior/biology and conflict prevention. The calendar is sold to local Wapiti residents as a school fundraiser each fall.

6. Bear Aware information is included in "Welcome Wagon" gift bags assembled by local businesses for new residents.

7. The Carcass Management program continues to provide a domestic livestock carcass removal service for livestock producers located in occupied grizzly bear habitat within Park County, Wyoming. The program is mirrored after an existing program utilized by landowners in the Blackfoot River watershed in western Montana and is paid for with funds from the Park County Predator Management District and the Wyoming Animal Damage Management Board. The program provides producers with an alternative to the use of on-site carcass dumps, which are a significant bear attractant and indirectly contribute to numerous human-bear conflicts. To date, 81 domestic livestock carcasses have been removed from private land with 20 participating landowners.

8. Provided recommendations concerning storage of garbage and other attractants for new development in occupied bear habitat to the Park County Planning and Zoning Commission. The Coordinator reviews developments on a case-by-case basis and attends monthly meeting. To date, these recommendations have been adopted as a condition of approval for seven new developments within Park County.

New Initiatives and Accomplishments:

1. A "Bear Identification for Black Bear Hunters" educational card was designed and printed. Cards were distributed to individuals and to local sporting goods stores in the Cody, Jackson, Pinedale, and Lander regions and mailed to black bear hunters who registered bait sites with the Wyoming Game and Fish Department in areas surrounding the GYA.

2. Over 30 presentations, workshop, and talks were given regarding human-bear conflict prevention to audiences including, but not limited to Wapiti, Eastside, Sunset, and Valley Elementary Schools, Boy Scouts, 4H, Park County Commissioners, residents attending Arbor Day, Clark and Meeteetse community residents, Bow Hunters of Wyoming, Wyoming Outfitters and Guides Association, and Trout Unlimited.

3. Provided Park County, Wyoming with estimates and options for bear-resistant recycling trailers for use in rural sections of the County. The Coordinator is seeking potential funding sources to offset the cost of bear-resistant recycling containers.

4. Worked with the Big Horn Basin chapter of Sportsman for Fish and Wildlife (SFW) to produce and air two public service announcements (PSAs) titled "Hunting Safely in Bear Country" and "Bear ID Tips for Black Bear Hunters". PSAs were aired on

three local radio stations for three weeks in September 2009 immediately before the opening of the elk rifle season and during the spring and fall black bear season. SFW paid for half of fall airtime cost.

5. A second "Hunting in Bear Country" public service announcement that was recorded in 2008 in cooperation with the Wild Sheep Foundation, ran for two weeks in September 2009.

6. A public service announcement regarding proper attractant management recorded by Wapiti school students aired for two weeks on three local radio stations in October 2009.

7. Worked with the Big Horn Basin chapter of Sportsman for Fish and Wildlife to develop and place a print ad encouraging hunters to carry bear spray. The 6"x8" ad was printed in *The Hunting Guide* published by the Cody Enterprise. The Big Horn Basin chapter of Sportsman for Fish and Wildlife paid for the ad entirely.

8. An article titled "Feeding Birds, not Bears" was included in a monthly publication produced by the local chapter of the Audubon Society.

9. A mailing containing information regarding human-bear conflict prevention and the availability of local resources was delivered to Wapiti residents. A refrigerator magnet featuring tips about proper attractant management was included in each mailing.

Objectives for 2010 include expansion of the program into the other areas of the state where human-bear conflicts are chronic, finalization and production of an interactive Bear Aware traveling display for use by educational institutions and libraries across northwest Wyoming, and the continuation of current educational and outreach efforts.

The Wapiti Bear Wise Community program faces the ongoing challenges of: 1) the absence of ordinances or laws prohibiting the feeding of bears; 2) limited educational opportunities and contact with portions of the community due to a large number of summer-only residents and the lack of organized community groups; and 3) complacency by some residents due to the relatively low occurrence of residential human-bear conflict in 2008 and 2009. The future success of the Bear Wise program lies in continued community interest and individual participation in proper attractant management.

Bear Wise Jackson Hole Project Update

In 2009, the Bear Wise Jackson Hole program focused public outreach efforts on education, signage, distribution of informational pamphlets, personal contacts, distribution of bear-resistant garbage carts, and implementation of the recently adopted Teton County "Bear Conflict Mitigation and Prevention" Land Development Regulation (LDR).

In 2007, WGFD staff developed a series of recommendations that would require private property owners within Teton County to store garbage and other attractants unavailable to bears. In April 2008, the Teton County Commissioners adopted these recommendations in the form of a LDR. The regulation requires that all residents and businesses within identified high conflict priority areas must store garbage and bird foods unavailable to bears. Sections of Teton County in phase one were required to comply by 1 July 2009 and other areas of the county in phase two must comply by 1 July 2010.

2009 Accomplishments:

1. A considerable amount of time was spent supporting Teton County and local waste management companies with the implementation of the first phase of the bear conflict mitigation and prevention LDR with various projects including: informational mailings, feature newspaper articles, public service announcements (PSAs), radio interviews and a full page color newspaper advertisement.

2. The WGFD worked closely with the Jackson Hole Wildlife Foundation on the sales and distribution of bear-resistant garbage carts, which were made available to the public at a reduced cost. To date, 90 carts have been placed. The remaining cart inventory has been liquidated to local waste management companies and has been distributed to their customers.

3. Recommendations were made to several businesses in Jackson to sell bear-resistant garbage carts locally. Ace Hardware in Jackson now carries a large inventory of bear-resistant garbage carts. They have been selling these carts to the public since July 2009.

4. Public service announcements were broadcast on four local radio stations for a total of eight weeks in the spring and fall of 2009. These announcements focused on storing attractants unavailable to bears and hunting safely in bear country.

5. Numerous educational talks were presented to various groups including homeowners associations, guest ranches, youth camps, Jackson residents, tourists, Backcountry Horsemen, Boy Scouts, and school groups.

6. Spanish language bear informational pamphlets were produced and distributed to Spanish speaking people in Teton County with the help of the Teton County Latino Resource Center and the Jackson Visitor Center.

7. Bear educational posters have been placed inside of Jackson's public buses for a one year period.

8. Restroom posters with information about attractant storage were placed in ten different restaurants in Teton County for a six month period.

9. A full page color ad was placed in the Jackson Hole News and Guide for two weeks starting on September 15. This ad contained information about hunting safely in bear country.

10. An educational “Bear Aware” display was set up in the lobby at the Wyoming Game and Fish Department Jackson office.

11. Numerous personal contacts were made with private residents in Teton County. This has proven to be a useful way to establish working relationships with residents and maintain an exchange of information about bear activity in specific areas.

12. A booth containing information on bear identification, attractant storage, hunting and recreating safely in bear country and the proper use of bear spray was staffed at the Jackson Hole Antler Auction.

13. Assisted three hunting outfitters and the Teton Science School with the installation and maintenance of electric fence systems around their field camps located in the Bridger-Teton National Forest.

14. Signage detailing information on hunting safely in bear country, bear identification, recent bear activity, and proper attractant storage were placed at U.S. Forest Service trailheads and in private residential areas throughout Teton County.

15. Consultations were conducted at multiple businesses and residences where recommendations were made regarding sanitation infrastructure and compliance with the Bear Conflict Mitigation and Prevention LDR.

16. Bear Aware educational materials were distributed to campground hosts in the Caribou-Targhee National Forest, hunters, and numerous residents in Teton County.

Objectives for the Bear Wise Jackson Hole program in 2010 will focus on supporting Teton County and local waste management companies with projects that will help disseminate information and achieve compliance with the second phase of the recently adopted Teton County Bear Conflict Mitigation and Prevention LDR. Specific objectives are as follows:

1. Develop, print, and distribute informational pamphlets containing information on responsible attractant management and the Bear Conflict Mitigation and Prevention LDR.

2. Placing ads in the Jackson Hole News and Guide detailing how to comply with the LDR.

3. Posting signage detailing the LDR. Signage will be placed in key residential locations throughout Teton County.

4. Develop and air public service announcements on local radio and television media outlets.

The recent implementation of the Teton County Bear Conflict Mitigation and Prevention LDR has greatly reduced the amount of available attractants on the landscape and is a tremendous step forward for the Bear Wise Jackson Hole program. The new challenges that we face will be implementing the second phase of this regulation in the southern parts of Teton County and achieving full compliance. Bear Wise Jackson Hole will convey the importance of compliance and offer ways to help residents comply through public outreach and education projects.

In order for the Jackson program to be successful, the program must continually identify information and education needs within the community while being adaptive to changing situations across different geographic areas. This will require us to coordinate with other government agencies and local non-government organizations working across multiple jurisdictions to develop a uniform and consistent message. If we achieve this level of coordination, we will be more effective in gaining support and building enthusiasm for Bear Wise Jackson Hole, directing resources to priority areas, and reaching all demographics.

References

Hodges, T., and M. Boyce. 2009. 2008 Wyoming Bear Wise Community Project update. Pages 50-55 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone Grizzly Bear Investigations: annual report of the Interagency Grizzly Bear Study Team, 2008. U.S. Geological Survey, Bozeman, Montana, USA.

Servheen, C., M. Haroldson, K. Gunther, K. Barber, M. Bruscino, M. Cherry, B. DeBolt, K. Frey, L. Hanauska-Brown, G. Losinski, C. Schwartz, and B. Summerfield. 2004. Yellowstone Mortality and Conflicts Reduction Report: Presented to the Yellowstone Ecosystem Subcommittee (YES) April 7, 2004.

2009 Hoback Grizzly Bear Camera Report

Wyoming Game and Fish Department

Trophy Game Section – Management/Research Branch

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January 8, 2010

INTRODUCTION

Documenting the occurrence of grizzly bears (*Ursus arctos*) on the periphery of their known or suspected distribution in Wyoming is important in determining areas of expansion and relative densities of grizzly bears as they recolonize new areas within the Greater Yellowstone Area (GYA). Accurate information on grizzly bear distribution will be valuable in efficiently allocating state resources and responsibilities for grizzly bear management. Within the past several years there have been sporadic sightings and conflicts with grizzly bears in this portion of the GYA. However, most of the sightings were associated with conflict situations where bears were either relocated or killed. The objective of this study was to document to what extent grizzly bears inhabit the southern fringe of their distribution in Wyoming (Schwartz et al. 2006).

STUDY AREA

The study area was located in western Wyoming northeast of the Wyoming Range and includes portions of the Hoback and Green River drainages (Figure 1). All camera sites were located on the Bridger-Teton National Forest in the Jackson and Big Piney Ranger Districts. Elevation of camera sites ranged from 2,058 meters (6,751 feet) to 2,804 meters (9,198 feet) with an average elevation of 2,291 meters (7,517 feet). Vegetation on the study area consisted primarily of aspen (*Populus tremuloides*), lodgepole pine (*Pinus contorta*), Douglas-fir (*Pseudotsuga menziesii*), Englemann spruce (*Picea englemannii*) and sub-alpine fir (*Abies lasiocarpa*). Whitebark pine (*Pinus albicaulis*), a preferred grizzly seasonal food source (Haroldson and Podruzny 2008, Kendall 1983, Blanchard 1990, Mattson and Reinhart 1997), was not observed in any of the camera grids but is present at higher elevations in western and northern portions of the study area. Adjacent meadow complexes were dominated by various species of sagebrush (*Artemesia* spp.) and included other forb and grass species.

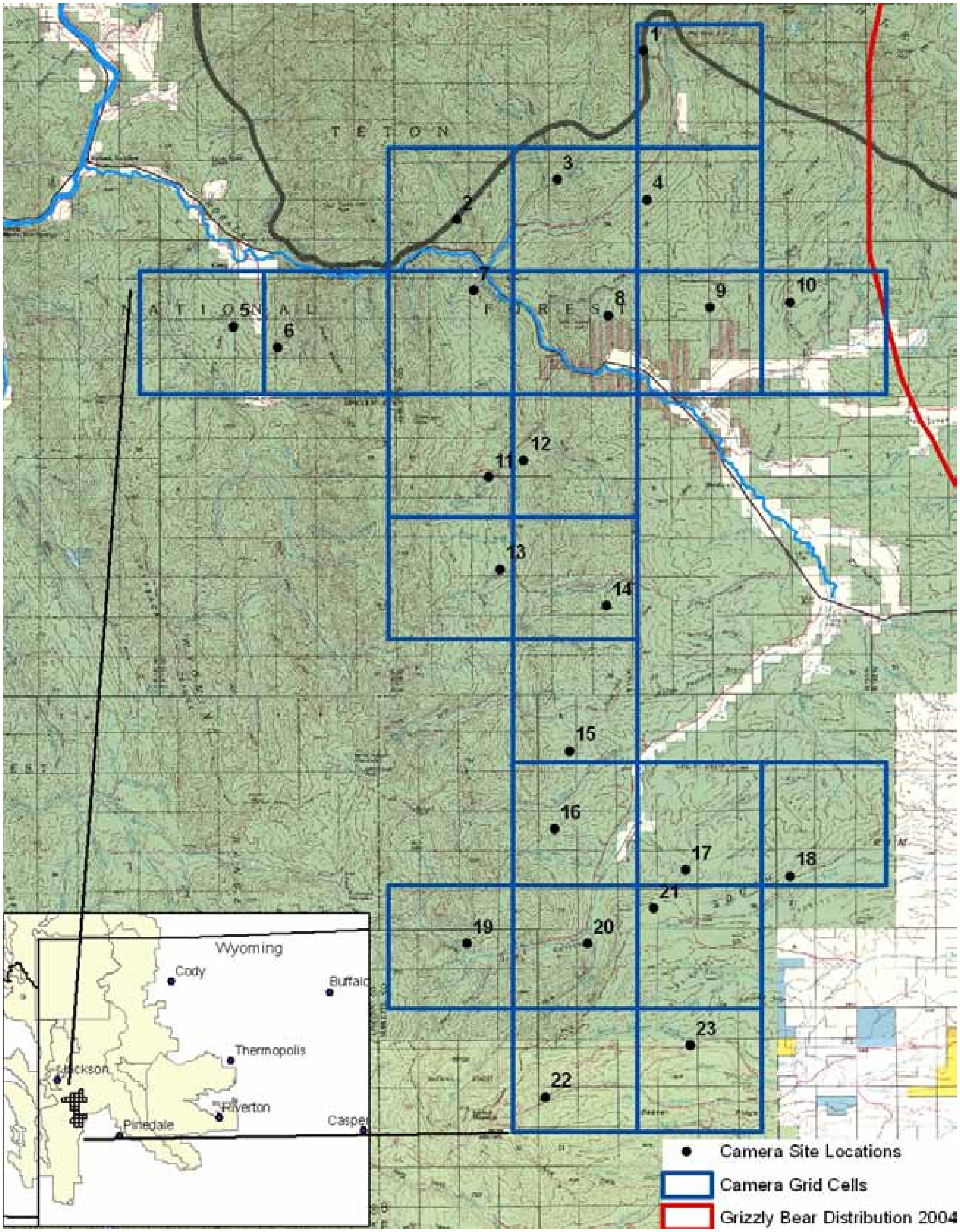

Figure 1. Location of study area including camera grid and camera sites, 2009

METHODS

Motion activated infra-red cameras were deployed in a systematic grid to document presence of grizzly bears in this portion of the ecosystem. The Department has used remote camera techniques since 2006 when first tested in the Black Rock area of Wyoming (Barr et al. 2007). Two Reconyx Professional Model PM35 (Reconyx, LLP, Holmen, WI, USA) cameras were attached to trees 1 to 2 meters above ground at each site. The cameras were positioned 90° to one another and directed at a focal point located under a scent lure, with one camera closer to the lure and the second further away to provide close-up and wide angle views for identification purposes. Distances from the lure ranged from 2.5 to 11 meters. The cameras were programmed to take 10 black and white photographs at 1-second intervals with a 30-second interval between sets of photos until movement stopped or the animal left the camera's field of view. Cameras were equipped with non-deterring, infrared flashes to facilitate nocturnal photos and were programmed to record date, time, photo number and ambient temperature on each photo.

The camera grid was comprised of 23 contiguous 5 km x 5 km cells (Wyoming Game and Fish Department [WGFD] 2008) encompassing 575 km^2 (Figure 1). Cell locations were selected based on ease of access with the requirement that they be contiguous. One camera site was established in each cell. Efforts were made to maximize the distance between each camera site and those in neighboring cells while maintaining accessibility. Sites near system roads and trails and developed areas were avoided to minimize human disturbances. If game trails were present, sites were located on or near the trail.

The scent lure consisted of putrefied livestock blood mixed with the anticoagulant, sodium citrate (http://www.nrmsc.usgs.gov/research/NCDElure.htm). Lure was placed in plastic jugs with a hole cut in the upper portion to allow for sent dispersal. The jugs were suspended with a rope 3–4.5 m above ground to prevent bears from accessing the lure. A small amount of lure was spilled on a small stump or chunks of wood placed on the ground immediately under the lure to attract bears to a focal point directly in front of the cameras where accurate identification was more probable. Two to four warning signs were attached to prominent trees within 100 meters of each site to warn people that bears may be nearby. UTM location, elevation, date, and time were recorded (Table 1).

Camera sites were visited weekly to inspect camera operation and alignment, change Compact Flash (CF) memory cards, and refresh scent lure, as needed.

An individual bear or family group detected by the cameras was counted as one event. Bears with obvious physical differences or a minimum two hour delay between photographic events were classified as separate events.

RESULTS AND DISCUSSION

Cameras were deployed between 6/26/09 and 7/2/09 and removed between 8/24/09 and 8/27/09. Cameras were in place for an average of 56.2 days per site. There was some variation in camera days among sites due to malfunction, extremely high livestock activity, and operator error. In all, 2,541 camera days were logged during the study period (Table 1).

Table 1. Hoback camera site summary data.

Site #	Elevation (m)	Elevation (ft)	Days Cameras in Place	Total Camera Days	Total Bear Events
1	2220	7284	57	114	12
2	2058	6751	57	114	5
3	2084	6838	57	114	0
4	2142	7026	57	114	5
5	2195	7201	55	110	4
6	2178	7144	54	108	3
7	2196	7204	55	110	2
8	2170	7119	55	110	6
9	2209	7248	56	112	4
10	2232	7322	56	112	2
11	2221	7287	57	114	0
12	2078	6817	57	114	2
13	2181	7155	57	114	1
14	2251	7386	57	114	2
15	2401	7877	54	108	5
16	2376	7796	55	81	3
17	2377	7797	56	112	5
18	2425	7955	55	110	1
19	2454	8052	56	98	3
20	2341	7681	56	112	1
21	2537	8324	55	110	0
22	2804	9198	59	118	0
23	2574	8445	59	118	0
Total			**1292**	**2541**	**66**

Sixty-six black bear *(Ursus americanas)* events and no grizzly bear events were recorded. Cameras detected from 1 to 12 events at the 18 sites visited by bears (Table 1). Of the 66 black bear events, 10 were of family groups; 1 female was accompanied by 3 cubs, 7 accompanied by 2 cubs, and 2 accompanied by 1 cub. The sex and age of all other bears could not be accurately determined. Black bear events were recorded during all hours of the day except for the nocturnal period from 2300–0400 hrs. Similar to previous WGFD camera studies (WGFD 2008, Lockwood et al. 2008), black bear visitation was highest during crepuscular hours (Figure 2). Unlike results of previous studies, the number of bear events in 2009 had two distinct peaks; two weeks into the study period and again at slightly over 4 weeks before tapering off (Figure 3).

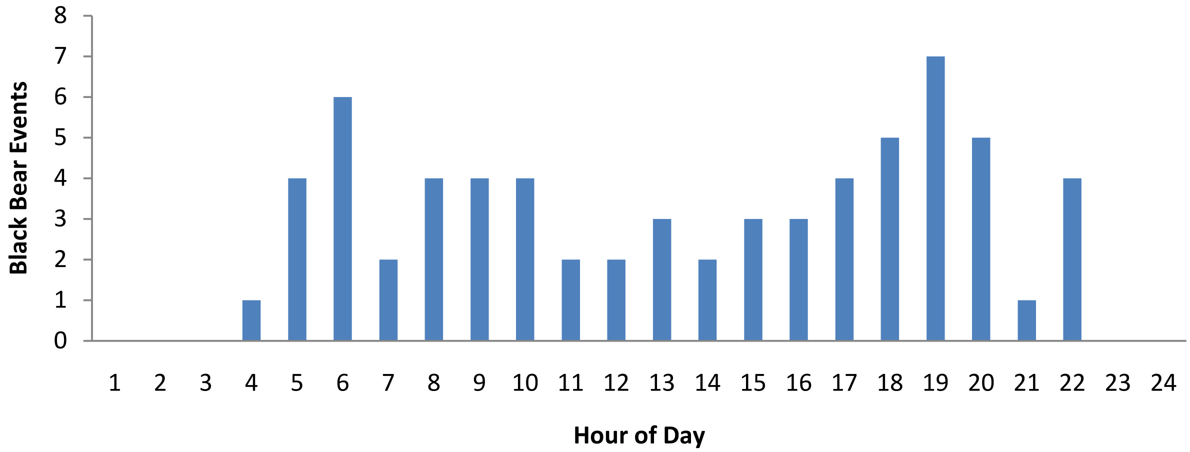

Figure 2. Black bear detection events by hour of the day.

Since elevations of camera sites ranged from 2,058 meters (6,751 feet) to 2804 meters (9,198 feet), sites were grouped into one of four, one thousand foot elevation ranges for analyses (6,000–6,999 ft., 7,000–7,999 ft., 8,000–8,999 ft., and 9,000–9,999 ft). There were 3 camera sites in the 6,000 ft. range, 16 in the 7,000 ft. range, 3 in the 8,000 ft. range and 1 in the 9,000 ft. range. The average number of black bear events per camera site within each of the four elevation ranges is illustrated in Figure 4. These results differ from previous studies (WGFD 2008, Lockwood et al. 2008) where black bears showed an affinity for habitats above 8,776 ft. and 9,200 ft., respectively. However, it should be noted that in 2009 only 1 camera grid was located above 9,000 ft. due to limited access. Approximately 85% (56/66) of the events occurred in the 7,000 ft. range, while 70% (16/23) of the camera sites were in this elevational range, which suggests that use was greater than expected. Black bear use at the 6,000 ft. range appears to be approximately equal to availability, while use at the 8,000 ft. and 9,000 ft. ranges was less than expected.

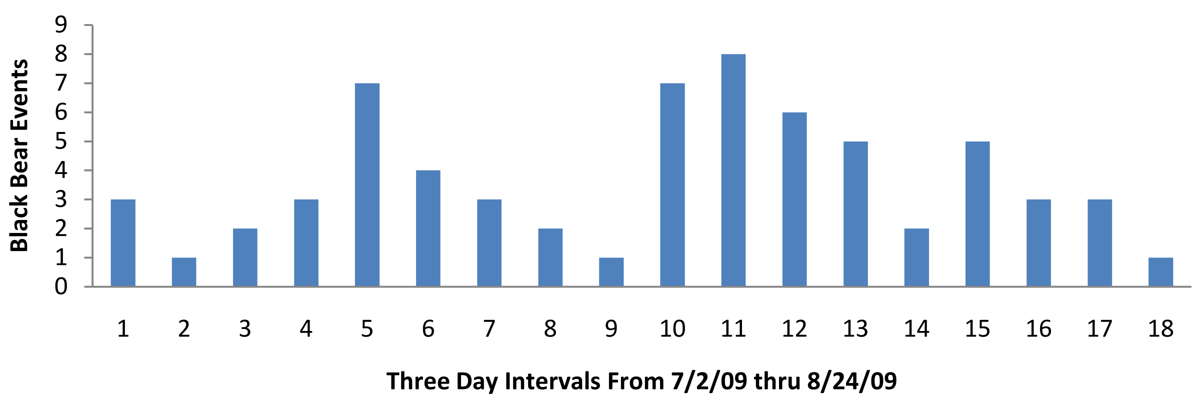

Figure 3. Black bear detection events broken down by three day intervals from 7/2/09 through 8/24/09.

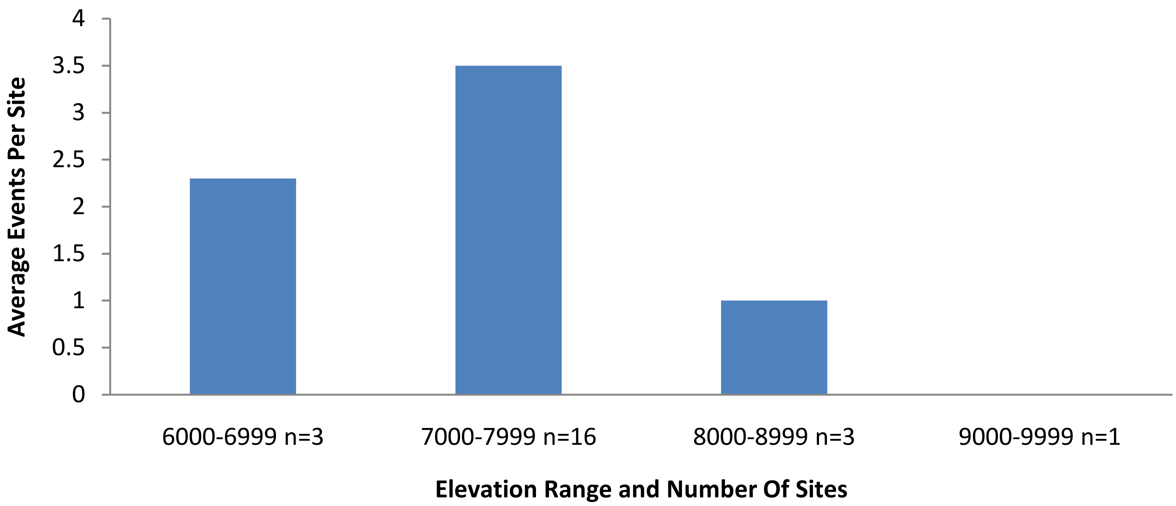

Figure 4. Average number of black bear detection events per site by elevation range.

In addition to black bear events, there were many other wildlife observations recorded including 941 mule deer (*Odocoileus hemionus*), 98 American marten (*Martes americana*), 60 moose (*Alces alces*), 40 snowshoe hare (*Lepus americanus*), 26 elk (*Cervus elaphus*), 14 coyote (*Canis latrans*), 2 gray wolves (*Canis lupus*), 1 American badger (*Taxidea taxus)*, 6 red fox (*Vulpes vulpes*), 4 North American porcupine (*Erethizon dorsatum*), 2 northern flying squirrel (*Glaycomys sabrinas*), 3 grouse (species undetermined), and several photos of other nongame bird and mammal species. Many of the photos undoubtedly were of individuals who visited the sites on multiple occasions. The counts represent the total number of individuals counted in photos regardless of the number of visits.

MANAGEMENT IMPLICATIONS

Systematic sampling is generally more representative and precise than random sampling (Mace et al. 1990, Morrison et al. 2001). Use of systematic sampling grids increases probability of detection of all bears in the area, not just bears frequenting specific attractants. It also allows for the development of detection probabilities, occupancy rates and, at times, density estimates. Systematic sampling is also more beneficial when used with long-term monitoring studies (Morrison et al. 2001) such as current grizzly bear research throughout the Greater Yellowstone Ecosystem. The 56 day study period would have been adequate to detect grizzly activity in the study area.

We did not document grizzly bear activity in the study area. Although there have been verified sightings and sign of grizzly bears documented in and around the study area in previous years, it is quite possible these sightings/sign were from transient animals or represent grizzly bears that are no longer alive. There may be seasonal movements occurring by grizzly bears that would not have been documented by our study (i.e., grizzly bear movement pre/post camera deployment). Previous research has documented that a 5 km x 5 km grid is optimal to document grizzly bear presence in occupied grizzly bear habitat (Mace et al. 1994, WGFD 2008, Lockwood et al.

2008). It is possible that grizzly bears were at higher elevations during the study period and therefore not documented on some of the peripheral camera sites of the grid. Although we did not document resident grizzly bears in the study area, it is valuable to discern that grizzlies are not using these habitats in the Hoback and Green River drainages regularly during July and August. It is likely that as grizzly bears expand their distribution, this area will be used with higher frequency, but our study suggests that currently grizzly bears do not use the study area during summer months.

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LITERATURE CITED

Barr, M. B., C. R. Anderson, D. S. Moody, and D. D. Bjornlie. 2007. Testing remote sensing cameras to count independent female grizzly bears with cubs of the year: pilot study. Wyoming Game and Fish Department, Trophy Game Section.

Blanchard, B. 1990. Relationship between whitebark pine cone production and fall grizzly bear movements. Pages 362-363 in W. C. Schmidt and K. J. McDonald, editors. Proceedings of symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource. U.S. Forest Service General Technical Report INT-270. U.S. Forest Service, Ogden, Utah, USA.

Haroldson, M. A. and S. Podruzny. 2008. Whitebark pine cone production. Pages 37-38 in C. C. Schwartz, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2007. U.S. Geological Survey, Bozeman, Montana, USA.

Kendall, K. C. 1983. Use of pine nuts by grizzly and black bears in the Yellowstone area. International Conference on Bear Research and Management 5:166-173.

Lockwood, S. T., L. I. Knox, D. D. Bjornlie, and D. J. Thompson. 2008. 2008 Wind River Indian Reservation Grizzly Bear Camera Study. Wyoming Game and Fish Department, Trophy Game Section.

Mace, R. D., T. L. Manley, and K. E. Aune. 1990. Use of systematically deployed remote cameras to monitor grizzly bears. Montana Department of Fish, Wildlife, and Parks. 25 pp.

Mace, R. D., T. L. Manley, and K. E. Aune. 1994. Estimating grizzly bear population size using camera sightings. Wildlife Society Bulletin. 22:74-83.

Mattson, D. J., and D. P. Reinhart. 1997. Excavation of red squirrel middens by grizzly bears in the whitebark pine zone. Journal of Applied Ecology 34:926-940.

Morrison, M. L., W. M. Block, M. D. Strickland, and W. L. Kendall. 2001. Wildlife Study Design. Springer-Verlag New York, NY.

Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. S. Moody. 2006. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. Ursus 17(1):63-66.

Wyoming Game and Fish Department, Trophy Game Section. 2008. Testing remote sensing cameras to count independent female grizzly bears with cubs of the year, 2006-2007.

2009 Annual Report

Greater Yellowstone Whitebark Pine Monitoring Working Group

Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

Introduction

Whitebark pine (*Pinus albicaulis)* is a high-elevation tree of the Northern Rocky Mountains, forming open woodlands on relatively xeric slopes (Arno and Hammerly 1977). In the conifer forests of eastern Idaho and western Wyoming, whitebark pine forest habitat types extend downslope from upper timberline on dry exposed ridges on sites too severe for subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). On less severe sites, whitebark pine extends further downslope and is a minor seral species in subalpine fir, Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*) habitat types (Steele et al. 1983).

In the Greater Yellowstone Ecosystem (GYE), whitebark pine, in mixed or dominant stands, occupies just over 2 million acres of the 24 million acres that comprise the area (Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee [GYCCWPS] 2010). While its relative inaccessibility and sometimes crooked growth form lead to low commercial value as timber, it is a highly valuable species ecologically and is often referred to as a "keystone" species (Tomback et al. 2001). Whitebark pine is considered a foundation species capable of changing forest structure and ecosystem dynamics (Ellison et al. 2005) in the subalpine zone. The relatively large seeds serve as an important high-energy food source for a variety of wildlife species, including red squirrels (*Tamiascurus hudsonicus*), Clark's nutcrackers (*Nucifraga columbiana*), and grizzly bears (*Ursus arctos horribilis*).

Whitebark pine has exhibited extensive declines over the past 50 years throughout major parts of its range (Kendall and Keane 2001). White pine blister rust (*Cronartium ribicola*) has already devastated the tree in parts of the Pacific Northwest (Kendall and Keane 2001, Koteen 2002) and the disease is well established throughout the Greater Yellowstone Ecosystem (Greater Yellowstone Whitebark Pine Monitoring Working Group [GYWPMWG] 2008). Mountain pine beetles (*Dendroctonus ponderosae*) are normally present at low population levels (Brown 1975, Baker and Veblen 1990), but periodic outbreaks have caused dramatic mortality events in the northern Rocky Mountains over the past century (Arno and Hoff 1990) including Yellowstone National Park in the 1970s (Despain 1990) and throughout the interior west more recently (Gibson 2006, Gibson et al. 2008).

Interagency Whitebark Pine Monitoring Program

Given the ecological importance of whitebark pine in the GYE and concerns over the long-term persistence of the tree species, the National Park Service Inventory & Monitoring program and others in the GYE collaborate on a long-term interagency monitoring program unified through the Greater Yellowstone Coordinating Committee. A monitoring working group of the Whitebark Pine Subcommittee works to integrate common interests, goals and resources of each agency into one unified monitoring program for the GYE. The Greater Yellowstone Whitebark Pine Monitoring Working Group consists of representatives from the U.S. Forest Service (USFS), National Park Service (NPS), U.S. Geological Survey (USGS), and Montana State University (MSU). This report is a summary of the monitoring data collected between 2004 and 2009 from this long-term monitoring project.

Monitoring objectives

The focus of the monitoring program is to detect how rates of blister rust infection change and to track the survival and regeneration of whitebark pine over time. A protocol for monitoring whitebark pine throughout the GYE was completed by the working group (GYWPMWG 2007*a*) and approved in 2007 by the NPS Intermountain Region Inventory and Monitoring Coordinator. Approved monitoring protocols are a key component of quality assurance helping to ensure methods are repeatable and detected changes are truly occurring in nature and not simply a result of measurement differences. The complete protocol is available at: http://www.greateryellowstonescience.org/subproducts/14/72.

Our monitoring objectives are to monitor the health of whitebark pine relative to levels of white pine blister rust and, to a lesser extent, mountain pine beetle.

Objective 1 - To estimate the proportion of live whitebark pine trees (>1.4 m tall) infected with white pine blister rust, and to estimate the rate at which infection of trees is changing over time.

Objective 2 - Within transects having infected trees, to determine the relative severity of infection of white pine blister rust in whitebark pine trees >1.4 m tall.

Objective 3 - To estimate survival of individual whitebark pine trees >1.4 m tall explicitly taking into account the effects of blister rust infection rates and severity, mountain pine beetle activity, fire and other damaging agents.

This monitoring effort provides critical information on the status of whitebark pine on a regional scale — that of the Greater Yellowstone Ecosystem. Monitoring results will help tell us whether whitebark pine is persisting as a functional part of the ecosystem and monitoring data can be used to justify and guide restoration and protection efforts.

Study Area

Our study area is within the GYE and includes six National Forests and two National Parks (the John D. Rockefeller Memorial Parkway is included with Grand Teton National Park) (Figure 1). The target population is all whitebark pine trees in the GYE. The sample frame includes stands of whitebark pine approximately 2.5 ha or greater within the grizzly bear Recovery Zone and was derived from the cumulative effects model for grizzly bears (Dixon 1997). Outside the Recovery Zone, the sample frame includes whitebark stands mapped by the US Forest Service. Areas that burned since the 1988 fires were excluded from the sample frame.

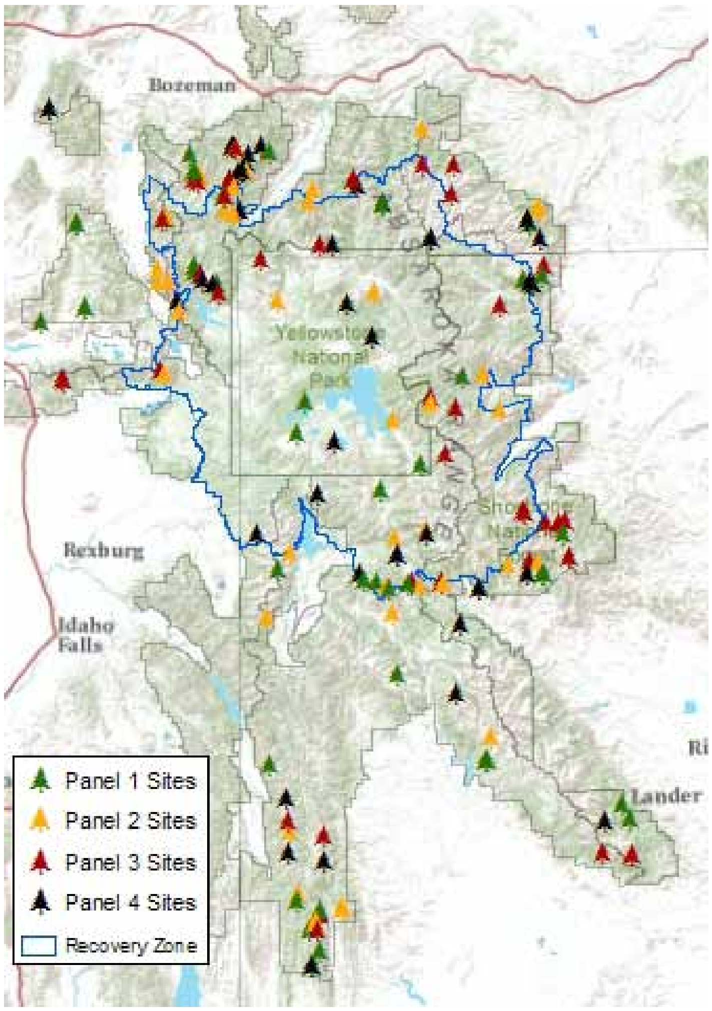

Figure 1. Location of whitebark pine survey transects, Greater Yellowstone Ecosystem. Panel 1 and 2 had a full resurvey for white pine blister rust infection in 2008 and 2009, respectively. Tree survival and indicators of mountain pine beetle were recorded on all but one transect.

Methods

Details of our sampling design and field methodology can be found in the Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem (GYWPMWG 2007*a*) and in past project reports (GYWPMWG 2005, 2006, 2007*b*, 2008, and 2009). The basic approach is a 2-stage cluster design with stands (polygons) of whitebark pine being the primary units and 10x50 m transects being the secondary units. The sample of 176 transects is a probabilistic sample that provides statistical inference to the GYE.

Initial establishment of permanent transects took place between 2004 and 2007. During this period 176 permanent transects in 150 whitebark pine stands were established and 4,774 individual live trees >1.4 m tall were permanently marked to estimate changes in white pine blister rust infection and survival rates over an extended period. In addition, the diameter at breast height, tree height class and indicators of mountain pine beetle were recorded for standing dead whitebark pine within the transects at the time of transect establishment. Dead trees were recorded as *recently dead* if the tree had persistent non-green needles.

In response to the current outbreak of mountain pine beetle, we doubled our monitoring efforts and resurveyed 175 transects between 2008 and 2009 to determine the survival of the permanently tagged trees and to record indicators of mountain pine beetle. Eighty-five transects were resurveyed in 2008 and another 90 in 2009 by two, 2-person crews. One crew was led by the NPS Greater Yellowstone Inventory & Monitoring Network; the other was led by the USGS Interagency Grizzly Bear Study Team. Half of all the permanent transects, essentially all the transects in panels 1 and 2, were resurveyed for changes in white pine blister rust infection in 2008 and 2009, respectively.

White Pine Blister Rust

For each live tree in panels 1 and 2, the presence or absence of indicators of white pine blister rust infection was recorded. For the purpose of analyses presented here, a tree was considered infected if either aecia or cankers were present. For a canker to be conclusively identified as resulting from white pine blister rust, at least three of five ancillary indicators are needed to be present. Ancillary indicators of white pine blister rust included flagging, rodent chewing, oozing sap, roughened bark and swelling (Hoff 1992).

Mountain Pine Beetle

For each live tree in panels 1though 4, pitch tubes and boring dust were recorded as evidence that the tree had been invaded with mountain pine beetle. Pitch tubes are small, popcorn-shaped resin masses produced by a tree as a means to stave off a mountain pine beetle attack. Boring dust is created during a mountain pine beetle attack and can be found in bark crevices and around the base of an infested tree. We checked beneath the bark of dead trees to look for J-shaped galleries where adult mountain pine beetle and their larvae live and feed.

Recruitment

At each 2 x 50 m belt transect, we count the number and determine the status of blister rust infection on all live trees <1.4 m tall. Recruitment that has grown to or above the 1.4m threshold are permanently tagged and added to our live tree database.

Analysis Methods

The proportion of trees infected with white pine blister rust is calculated using a design-based ratio estimator that accounts for the total number of mapped stands within and outside the grizzly bear Recovery Zone.

We continue to investigate the role of observer variability in blister rust detection (see Huang 2006) and detection of mountain pine beetle indicators. Each field season, 25% (approximately 10) of the full blister rust survey transects are subject to the double observer survey described in the working group protocol (GYWPMWG 2007*a*). We periodically examine the consistency between observers and correct problems through improved training and retention of trained and experienced observers. If the observer variability is found to be a large contributor to the standard error for our estimated parameters, we will assess this in our data analysis.

Results

Status of tree survival and presence of mountain pine beetle

There is currently widespread mortality of whitebark pine in the GYE associated with the current mountain pine beetle outbreak. Large diameter trees are the hardest hit during a mountain pine beetle outbreak as beetles preferentially attack large trees over small trees (Gibson et al. 2008).

We examined all permanently tagged trees >1.4 m tall in panels 1 through 4 to determine the living status of each tree. Out of the 4,748 whitebark pine trees examined, 10% (*n* = 492) had died. We looked for J-shaped galleries beneath the bark of each dead tree for evidence of mountain pine beetle infestation and found that 60% (*n* = 294) of the dead trees had J-shaped galleries. Consistent with mountain pine beetle preference for larger sized trees, tree mortality since 2004 was much greater in the large tree size class. Of the 429 trees >30 cm at DBH, we found 36% (*n* = 156) had died, whereas of the 4,317 trees ≤30 cm at DBH, only 8% (*n* = 335) had died during the same time period.

Based on these data, we calculate the survival of whitebark pine in our sample population at 90%. Field crews also recorded fading crowns, pitch tubes and boring dust, as indicators of mountain pine beetle attack on living trees. Eight percent of the living trees had pitch tubes indicative of mountain pine beetle infestation.

We added the standing dead trees that still had persistent non-green needles at the time of transect establishment to calculate the proportion of live and dead trees >1.4 m tall by size class shown in Figure 2. This same dataset was used to recalculate the percent of dead trees >30 cm or ≤30 cm at DBH that have died over approximately the last 10 years. Cumulatively, of the 475 standing trees >30 cm at DBH, 43% (*n* = 202) have died, whereas of the 4,468 trees ≤30 cm at DBH, 11% (*n* = 486) have died. Among all 688 standing dead trees believed to have died in the last decade, 57% (*n* = 395) had J-shaped galleries beneath the bark.

In a summary of mountain pine beetle impacts in high elevation five-needle pines, Gibson et al. (2008) state that they "anticipate beetle populations to remain high as long as weather conditions are conducive to beetle survival and/or until most mature host trees have been killed." Tree size is an important measure of host susceptibility. Furniss and Carolin (1977) report that trees from 10 to 12.5 cm in diameter up to those of the largest size may be attacked by mountain pine beetle. Waring and Six (2005) report that trees <5.08 cm (2") DBH are considered too small to support bark beetles. We found 3 trees <13.2 cm DBH with J-shaped galleries, with the smallest being 6.9 cm, however J-shaped galleries began to increase on trees ≥12 cm DBH. Based on tree size alone, 38% of the remaining live whitebark pine trees in our monitoring study are in the size class (≥12 cm) most susceptible to mountain pine beetle attack.

Besides mountain pine beetle, fire burned 4 of our monitoring transects and 13% (*n* = 66) of the dead trees had been scorched by fire.

An important distinction between this monitoring and that of Aerial Detection Survey (ADS) methods is that we use ground based search efforts to detect trees of all size

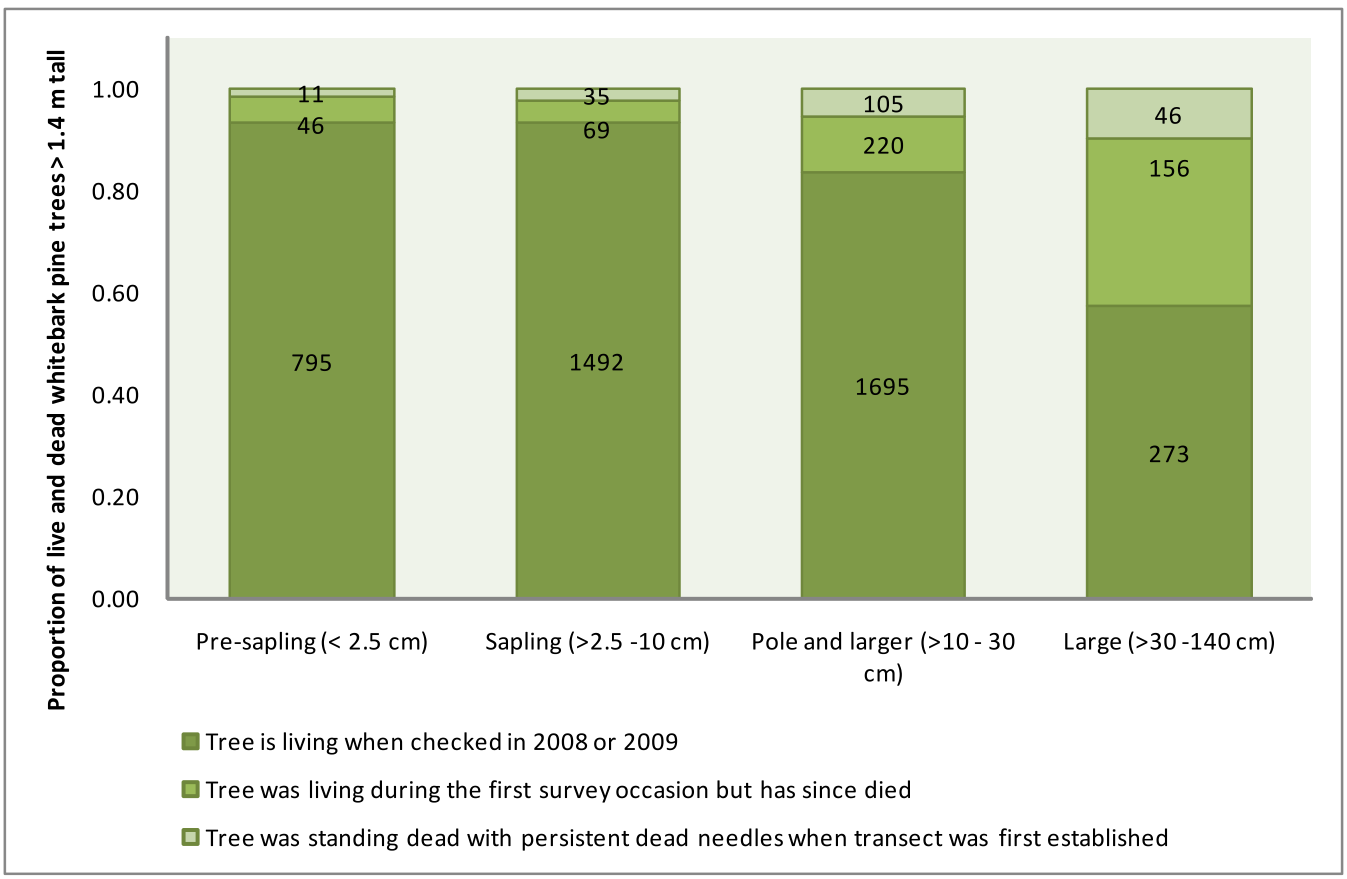

Figure 2. Proportion of living, dead and recently dead whitebark pine trees >1.4 m tall by size class. Categories show the status of trees that were alive and permanently tagged when transects were established and trees that were recently dead during the first survey. Transects were established between 2004 and 2007. A recently dead tree has persistent non-green needles and a dead tree has shed all its needles.

classes whereas ADS and other remote sensing methods use airborne platforms to search for and/or measure changes in the forest canopy. This distinction explains why our mortality estimates differ from aerial detection surveys and mortality assessments recently completed by the USDA Forest Service (Gibson 2006, Gibson et al. 2008), the Forest Service Remote Sensing Application Center (Goetz et al. 2009), and a more recent aerial detection of mountain pine beetle-caused mortality effort completed by Macfarlane et al. (2010).

Status of White Pine Blister Rust

The 2007 baseline estimate of the proportion of live trees with blister rust in the GYE was 0.20 (± 0.037 se) (GYWPMWG 2008). This estimate was based on data from 4,774 individual live trees in 176 transects collected over a 4-year period between 2004 and 2007 after all transects and tree records were established. We report here in Table 1 estimates of the proportion of whitebark pine trees infected with white pine blister rust based on the resurveys of panels 1 and 2, conducted in 2008 and 2009, respectively (Figure 3). We are presenting the results from each panel separately until after 2011 when all panels have been resurveyed at least once and we can combine data for trend analysis.

Changes in the count of infected trees by transect over time and its variability is shown in Figure 3. Blister rust infection has increased in some transects and decreased in others. In some transects, decreases in blister rust infection can be explained by the death of infected trees either by wildfire or after having been infested with mountain pine beetle. Increases in blister rust infection can only be explained by the increased number of trees with evidence of blister rust infection however we cannot say exactly when the increase took place. Burns et al. (2008) explain that increases in blister rust infection generally occur when cool temperatures and high relative humidity favor disease spread and intensification. As such the incidence of pine infection may increase substantially during years when optimum environmental conditions coincide with spore production dissemination, germination, and infection. They refer to these events as “wave years” (Burns et al.

Table 1. Design based ratio estimates for the proportion of infected whitebark pine >1.4 m tall in panel 1 and 2 and other summary information (Irvine 2010).

2008 [Panel 1]			
Location	**Within Recovery Zone**	**Outside Recovery Zone**	**Total for GYE**
Total number of mapped polygons/stands	2,362	8,408	10,770
Number of stands	15	22	37
Number of transects	15	27	42
Number of unique trees sampled	323	661	984
Proportion of transects infected	13 of 15	19 of 27	32 of 42
CI for proportion of trees infected in 2008	[0.018 , 0.255]	[0.205 , 0.357]	[0.186 , 0.312]
Proportion of trees infected in 2008	0.137 (se = 0.055)	0.28 (se = 0.036)	0.249 (se = 0.031)
2009 [Panel 2]			
Location	**Within Recovery Zone**	**Outside Recovery Zone**	**Total for GYE**
Total number of mapped polygons/stands	2,362	8,408	10,770
Number of stands	16	21	37
Number of transects	16	28	44
Number of unique trees sampled	295	684	979
Proportion of transects infected	13 of 16	26 of 28	39 of 44
CI for proportion of trees infected in 2009	[0.0184 , 0.301]	[0.3436, 0.595]	[0.295 , 0.501]
Proportion of trees infected in 2009	0.159 (se = 0.066)	0.465 (se = 0.062)	0.398 (se = 0.051)

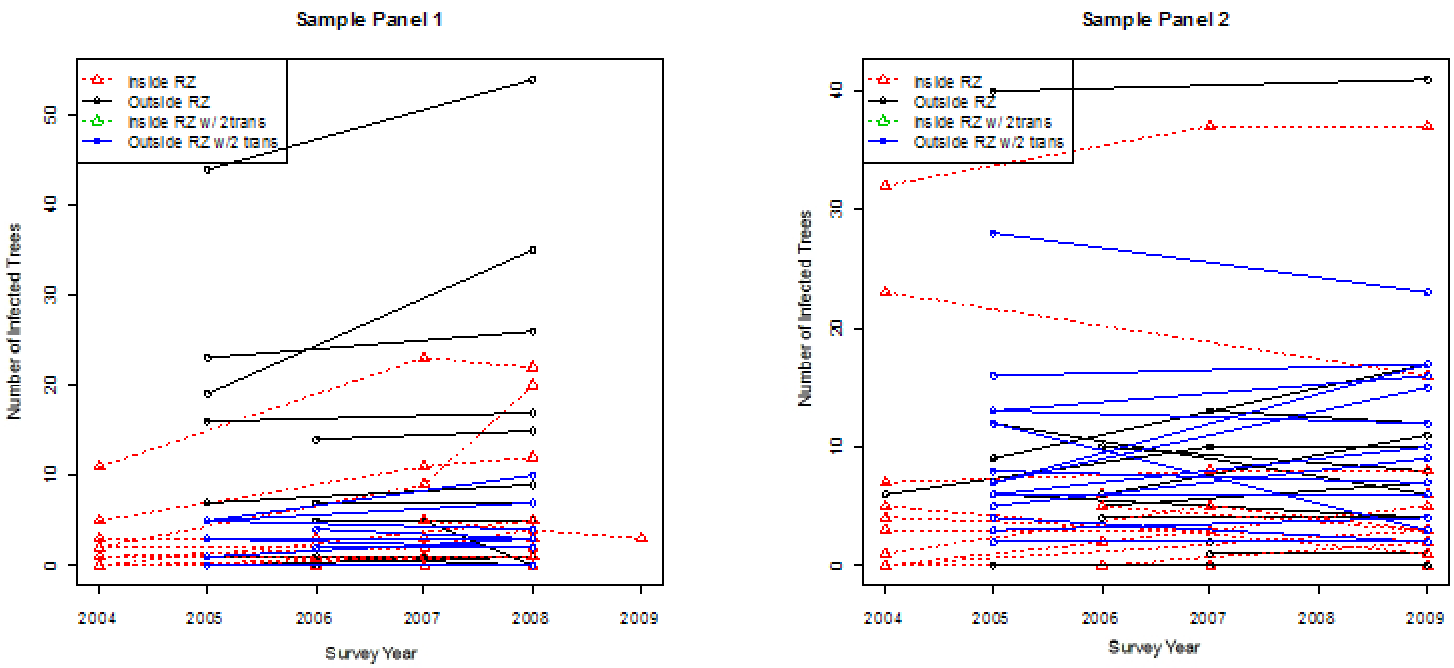

Figure 3. The count of live trees >1.4 m tall infected with white pine blister rust by transect on each survey occasion. Sample panels 1 and 2 are shown separately. Some transects inside the Recovery Zone have been resurveyed 3 times (Irvine 2010).

2008). Our ability to detect blister rust infection soon after an infection event, such as a wave year, is confounded by the year or more that it takes for the aecia to break through the infected bark and our revisit schedule for resurveying transects.

Whitebark pine surviving the current mountain pine beetle outbreak will continue to be stressed by white pine blister rust. Blister rust affects all aspects of the forest regeneration process. Unlike mountain pine beetle that attack larger trees, white pine blister rust infects all size classes and causes mortality in both young and old trees. High levels of blister rust can affect the sustainability of the population (Schoettle and Sniezko 2007) and influence ecosystem recovery long after the current beetle epidemic is over. Long term monitoring conducted by the Interagency Whitebark Pine Monitoring Working Group will detect how rates of blister rust infection change and track the survival and generation of whitebark pine in the Greater Yellowstone Ecosystem over time.

Whitebark Pine Recruitment

We use ground based methods to monitor recruitment of young trees into the reproductive population by tracking and recording the presence of cones or cone scars on individual trees. Twenty-four percent of the live trees >1.4 m tall are mature enough to have produced cones at least once. Counts of unique small trees <1.4 m tall within transects document densities of live trees in the understory ranging from 0 to 12,500 per hectare ($\bar{x}$ = 865, SE = 114, *n* = 176). Since 2007, 145 trees have grown up to or above the 1.4 m tall threshold and were subsequently tagged and added to the live tree database in 2008 or 2009.

Future Directions

In 2010 we plan to conduct a full resurvey for each transect in panel 3 and a partial resurvey focused on mountain pine beetle indicators in panel 1. As before, both surveys will record tree status as live, dead, or recently dead. If adequate funding is available, we will resurvey another 2 panels in 2011. Once we have a complete resurvey for white pine blister rust at the end of 2011, we can determine changes in the proportion of trees with white pine blister rust in the GYE.

The USGS Status and Trend program has funded the Interagency Grizzly Bear Study Team to conduct an integrated synthesis and analysis of our whitebark pine data. This project will explore the rate of blister rust infection and mountain pine beetle mortality in the GYE using spatial regression models and a suite of spatially explicit covariates. The NPS Greater Yellowstone Inventory & Monitoring Network staff and statisticians from Department of Mathematics Sciences at Montana State University are collaborating with the study team on this project.

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Literature Cited

Arno, S.F., and R.P. Hammerly. 1977. Northwest Trees. Mountaineers Books, Seattle, Washington, USA.

Arno, S.F., and R.J. Hoff. 1990. *Pinus albicaulis* Engelm. Whitebark Pine. Pages 268–279 *in* R.M. Burns and B.H. Honkala (technical coordinators), Silvics of North America, Vol. 1: Conifers. USDA Forest Service, Agriculture Handbook 654, Washington, D.C., USA.

Baker, W.L., and T.T. Veblen. 1990. Spruce beetles and fires in the nineteenth-century subalpine forests of western Colorado, USA. Arct. Alp. Res. 22:65–80.

Brown, J.K. 1975. Fire cycles and community dynamics in whitebark pine forests. Pages 429–56 *in* D.M. Baumgartner, editor, Management of whitebark pine ecosystems. Washington State Univ. Coop. Ext. Ser., Pullman, Washington, USA.

Burns, K.S., A.W. Schoettle, W.R. Jacobi, M.F. Mahalovich. 2008. Options for the management of white pine blister rust in the Rocky Mountain Region. Gen. Tech. Rep. RMRS-GTR-206. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Fort Collins, Colorado, USA.

Despain, D.G. 1990. Yellowstone vegetation: consequences of environment and history in a natural setting. Roberts Rinehart, Boulder, Colorado, USA.

Dixon, B.G. 1997. Cumulative Effects Modeling for grizzly bears in the Greater Yellowstone Ecosystem. Thesis, Montana State University, Bozeman, Montana, USA.

Ellison, A.E., M.S. Banks, B.D. Clinton, E.A. Colburn, K. Elliott, C.R. Ford, D.R. Foster, B.D. Kloeppel, J.D. Knoepp, G.M. Lovett, J. Mohan, D.A. Orwig, N.L. Rodenhouse, W.V. Sobczak, K.A. Stinson, J.K. Stone, C.M. Swan, J. Thompson, B. Von Holle, and J.R. Webster. 2005. Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. Frontiers in Ecology and the Environment 3(9):479–486.

Furniss, R.L., and V.M. Carolin. 1977. Western Forest Insects. Misc. Publ. 1339. USDA Forest Service, Washington, D.C., USA.

Gibson, K. 2006. Mountain pine beetle conditions in whitebark pine stands in the Greater Yellowstone Ecosystem, 2006. USFS Forest Health Protection, Numbered Report 06-03, Missoula, Montana, USA.

Gibson, K., K. Skov, S. Kegley, C. Jorgensen, S. Smith, and J. Witcosky. 2008. Mountain pine beetle impacts in high-elevation five-needle pines: current trends and challenges. USFS Forest Health Protection, Number report R1-08-020, Missoula, Montana, USA.

Goetz, W., P. Maus, and E. Nielsen. 2009. Mapping whitebark pine canopy mortality in the Greater Yellowstone area. RSAC-0104-RPT1. U.S. Department of Agriculture, Forest Service, Remote Sensing Application Center, Salt Lake City, Utah, USA.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2005. Interagency Whitebark Pine Health Monitoring Program for the Greater Yellowstone Ecosystem, 2004 Annual Report. Pages 92–125 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2004. U.S. Geological Survey, Bozeman, Montana, USA.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2006. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2005 Annual Report. Pages 73–80 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2005. U.S. Geological Survey, Bozeman, Montana, USA.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2007*a*. Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem, Version 1.00. Greater Yellowstone Coordinating Committee, Bozeman, Montana, USA.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2007*b*. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2006 Annual Report. Pages 46–54 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2006. U.S. Geological Survey, Bozeman, Montana, USA.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2008. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2007 Annual Report. Pages 50–56 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2007. U.S. Geological Survey, Bozeman, Montana, USA.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2009. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2008 Annual Report. Pages 62–68 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2008. U.S. Geological Survey, Bozeman, Montana, USA.

Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee. 2010. Whitebark Pine Strategy for the Greater Yellowstone Ecosystem (Draft Strategy dated 3/15/10).

Huang, M. 2006. A statistical analysis of observer variability in the identification of blister rust infection occurring in white-bark pine monitoring. Unpublished report prepared for the Whitebark Pine Monitoring Working Group. Department of Mathematical Sciences, Montana State University, Bozeman, Montana, USA.

Hoff, R.J. 1992. How to recognize blister rust infection on whitebark pine. USDA Forest Service, Intermountain Research Station, Research Note INT-406, Ogden, Utah, USA.

Irvine, K. 2010. Greater Yellowstone Network: status estimates for white pine blister rust. Report in partial fulfillment for RM CESU Task Agreement. National Park Service, Greater Yellowstone Network, Bozeman, Montana, USA.

Kendall, K.C., and R.E. Keane. 2001. Whitebark pine decline: infection, mortality, and population trends. Pages 221–242 *in* D.F. Tomback, S.F. Arno, and R.E. Keane, editors. Whitebark pine communities. Island Press, Washington, D.C., USA.

Koteen L. 2002. Climate change, whitebark pine, and grizzly bears in the Greater Yellowstone Ecosystem. Pages 343–414 *in* S.H. Schneider and T.L. Root, editors. Wildlife responses to climate change: North American case studies. Island Press, Washington D.C., USA.

Macfarlane W.W, J.A. Logan, and W.R. Kern. 2010. Using the Landscape Assessment System (LAS) to Assess Mountain Pine Beetle-Caused Mortality of Whitebark Pine, Greater Yellowstone Ecosystem, 2009: Project Report. Prepared for the Greater Yellowstone Coordinating Committee, Whitebark Pine Subcommittee, Jackson, Wyoming, USA.

Schoettle, A.W., and R.A. Sniezko. 2007. Proactive intervention to sustain high-elevation pine ecosystems threatened by white pine blister rust. Journal of Forest Research 12:327–336.

Steele, R., S.V. Cooper, D.M. Ondov, D.W. Roberts, and R.D. Pfister. 1983. Forest habitat types of eastern Idaho-western Wyoming. USDA Forest Service General Technical Report INT-144. Intermountain Forest and Range Experiment Station, Ogden. Utah, USA.

Tomback D.F., S.F. Arno, and R.E. Keane. 2001. The compelling case for management intervention. Pages 3–25 *in* D.F. Tomback, S.F. Arno, and R.E. Keane, editors. Whitebark pine communities: ecology and restoration. Island Press, Washington, D.C., USA.

Waring, K.M., and D.L. Six. 2005. Distribution of bark beetle attacks after whitebark pine restoration treatments: a case study. Western Journal of Applied Forestry 20(2):110–116.

Cooperating Organizations:

Greater Yellowstone Coordinating Committee (GYCC)

USDA Forest Service
Forest Health Protection
Beaverhead-Deerlodge National Forest
Bridger-Teton National Forest
Caribou-Targhee National Forest
Custer National Forest
Gallatin National Forest
Shoshone National Forest

USDI National Park Service
Greater Yellowstone Inventory and Monitoring Network
Grand Teton National Park
John D. Rockefeller, Jr. Memorial Parkway
Yellowstone National Park

USDI Geological Survey
Interagency Grizzly Bear Study Team
Northern Rocky Mountain Science Center
National Biological Information Infrastructure

Montana State University
Department of Mathematical Sciences

Greater Yellowstone Whitebark Pine Monitoring Working Group

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Greater Yellowstone Whitebark Pine Monitoring Working Group: a workgroup of the Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee

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[a] This project represented a collaboration in the truest since of the word, such that distinguishing order of participants with respect to relative contribution was virtually impossible. Consequently, order of participants is alphabetical.

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Copies of this, and other products from this project can be found at the Greater Yellowstone Science Learning Center at: http://www.greateryellowstonescience.org/topics/biological/vegetation/whitebarkpine.